umAREPS-30

Defense Information Infrastructure (DII)

Common Operating Environment (COE)

User's Manual (UM) for Advanced Refractive Effects Prediction System

Document Version 3.0

09 January 2003

Prepared for:

Space and Naval Warfare Systems Command
METOC Systems Program Office (SPAWAR PMW-155)
San Diego, CA

Prepared by:

Space and Naval Warfare Systems Center, San Diego
Atmospheric Propagation Branch
San Diego, CA

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GETTING STARTED

About AREPS

The Advanced Refractive Effects Prediction System (AREPS) program computes and displays a number of tactical decision aids. These are airborne and surface-based radar probability of detection, electronic surveillance measure (ESM) vulnerability, UHF/VHF communications, simultaneous radar detection and ESM vulnerability, and a surface-search range table. All decision aids are displayed as a function of height, range, and bearing. Detection probability, ESM vulnerability, communication, and surface-search range assessments are based on electromagnetic (EM) system parameters stored in a changeable database you maintain. In addition to detection probabilities, program outputs may be displayed as propagation loss, propagation factor, and signal-to-noise. Paths containing land features depend on terrain data either obtained from the National Imagery and Mapping Agency's (NIMA) Digital Terrain Elevation Data (DTED) or specified from your own source.

All calculations depend on atmospheric refractivity data derived from radiosondes or other sensors. The propagation model used is the Advanced Propagation Model (APM). AREPS creates a height versus range coverage or surface-search range diagram for each azimuth desired. When all coverage diagrams requested have been computed, AREPS displays the coverage diagrams in rapid sequence, rotating through the various azimuths. You may change the rotation speed, pause the sequence at any azimuth, step the sequence forward in azimuth one diagram at a time, or step the sequence backward in azimuth one diagram at a time. For each diagram, you may also display a number of other decision aids and obtain additional information. All of these features are selectable from pop-up menus. Right-click anywhere upon the coverage display to open these menus. Using a mouse or other pointing device you may display many additional pieces of information to include height, range, latitude, and longitude from the decision aid's geographical center, terrain elevations, and pathloss values.

Propagation Models

Advanced propagation model

The internal propagation model for AREPS is the Advanced Propagation Model (APM). This is a hybrid model that consists of four sub-models: flat earth, ray optics, extended optics, and split-step parabolic equation (PE). APM effectively merges both the Radio Physical Optics (RPO) model and the Terrain Parabolic Equation Model (TPEM). The result is a new and improved EM propagation model that has the following capabilities:

1. Range-dependent refractivity environments
2. Variable terrain
3. Range-varying dielectric ground constants for finite conductivity and vertical polarization calculations.

4. Troposcatter
5. Gaseous absorption

APM may not necessarily give coverage all heights and ranges within a specified coverage area. APM runs in three execution modes, depending on system and environmental inputs specified within AREPS. These modes are:

1. Full hybrid: This execution mode will give coverage at all heights and ranges within a specified coverage area provided the emitter is surface-based and the propagation path is initially flat for the first 2.5 km. This is particularly well suited for a coastal region area where coverage is desired from a ship looking inland towards the coast.

2. Partial hybrid: This execution mode will run only the PE and extended optics sub-models if the terrain elevation is non-zero at the source AND if the source height is less than 100 meters above the local ground. This will result in a coverage diagram that does not have coverage at very high propagation angles (i.e., short ranges and high altitudes).

3. Pure PE: This execution mode will run ONLY the split-step PE sub-model for source/emitter heights greater than 100 meters above the local ground (or above mean sea level) regardless of terrain path. This will result in a coverage diagram that does not have coverage at very high propagation angles above and below the source (i.e., short ranges and high/low altitudes).

Radio physical optics

H.V. Hitney, "Hybrid Ray Optics and Parabolic Equation Methods for Radar Propagation Modeling," IEE International Conference 365, "Radar 92," pp. 58-61, October 1992.

W.L. Patterson and H.V. Hitney, "Radio Physical Optics CSCI Software Documents," NCCOSC RDTE DIV Technical Document 2403, December 1992.

W.L. Patterson and H.V. Hitney, "Radio Physical Optics (RPO) CSCI Software Documents, RPO Version 1.16," NCCOSC RDTE DIV Technical Document 2403, Rev. 1, April 1997.

Terrain parabolic equation model

A.E. Barrios, "A Terrain Parabolic Equation Model for Propagation in the Troposphere," IEEE Trans. Antennas and Propagation, vol. 42, no. 1, January 1994.

Engineer's Refractive Effects Prediction System

The Engineer's Refractive Effects Prediction System (EREPS) is a system of individual stand-alone IBM/PC-compatible programs to aid an engineer in properly assessing electromagnetic propagation effects of the lower atmosphere on proposed radar, electronic warfare, or communications systems. The standard propagation models of EREPS may be obtained from our World Wide Web homepage, http://sunspot.spawar.navy.mil.

Installing/Uninstalling AREPS

Hardware and Operating System Requirements

You may install and run AREPS on an IBM PC or 100 percent compatible computer running the U.S. English regional version of the Microsoft Windows® operating system. The minimum hardware requirement to run AREPS is the same as the minimum requirements for the operating system. A CD-ROM drive is highly recommended. To take advantage of the full capabilities of the AREPS program, we recommend a Pentium class computer, at least 16 megabytes of random access memory (RAM), a large hard disk drive (1 gigabyte or larger), and a printer. While the AREPS program has been tested in all screen modes for large and small fonts, it is designed for an 800x600 (or larger) small font display. Should the AREPS windows fail to appear in proper proportion or scroll bars appear on all AREPS windows, we recommend setting the computer's display to the 800x600 (or larger) small font mode if your monitor will allow it. You also have the option to change the AREPS font from the "fonts" item on the Options menu.

The AREPS program runs under the U.S. English regional setting of the Windows operating system. If your regional setting is something other than U.S. English, AREPS may not function correctly. Some regional settings substitute the comma character for the decimal point character. This will cause type mismatch errors while working with the EM system database. If this occurs and you still desire to use AREPS, you must change your regional setting to U.S. English. This change is made from the regional setting icon found in the Windows Control Panel.

Installing AREPS

AREPS normal distribution is via the Internet or on a CD-ROM. Contact technical support about other distribution options.

If you are installing AREPS under Windows NT/2000, you must have system administrator authority.

▶ To obtain and install AREPS from the Internet.

Steps	Comments
1	Request the AREPS software from our Internet homepage (http://sunspot.spawar.navy.mil) by clicking on the **Obtain AREPS** hypertext link found on our software page.
2	Complete the AREPS registration form. If you request, we will use your email address to inform you of any software service packages or other items of general interest. Your information will not be used for any other purpose. When the registration form is complete, click on the **Send request to SSC** button.
3	For your convenience, AREPS is available in two package formats. For those with a high-speed Internet connection, we have packaged AREPS into a single large file. For those with a slow-speed Internet connection, we have segmented AREPS into parts, each of which is sized to fit on a 3.5-inch floppy diskette. Click on the hypertext link for the single file or the individual segments and save it (them) in a temporary folder. The single file need not be saved but may be executed directly from our homepage.
4	Should you choose to save the installation file(s), move to the temporary folder and double click on the single file's name (*arepssetup.exe*) or the first segment's file name (*areps1.exe*).
5	For the single file, double clicking on the file name will start the installation process. For the segmented file, it will automatically expand its contents. The default expansion folder is your system's temporary folder, but you may choose any folder as long as it contains the other segment files. Once expanded, double click *Setup.exe* and follow any instructions provided on the screen. After AREPS is installed, you may delete all the compressed and expanded segment files. Prior to deleting the compressed segment files, you may wish to copy them onto floppy diskettes for installation on another computer.

▶ **To install AREPS from a CD-ROM.**

Steps	Comments
1	Insert the CD-ROM distribution disk into your CD drive.
2	Click the **Start** button, point to **Settings**, and then click the **Control Panel** icon.
3	Double click the **Add/Remove Programs** icon.
4	Follow the instructions on your screen.

▶ **To create AREPS program shortcut.**

To get to the AREPS program more quickly once it is installed, you may wish to create a shortcut icon on your desktop.

Steps	Comments
1	In My Computer or Windows Explorer, locate the *AREPS.EXE* file.
2	Using the right mouse button, drag the program icon to the desktop.
3	Click Create Shortcut(s) here.

While installing AREPS, you may encounter several notices. The first notice will occur if your installation initialization files are older than those provided with AREPS. You will be asked to accept the new initialization files and restart your computer. If you choose to do so, just select the affirmative response. If not, you will not be able to install AREPS. A second notice may occur if you are using Windows NT 4.0. The notice will say you should update your Windows NT with a particular service package. If the service package is not installed, AREPS may not work correctly. Service packages may be obtained from Microsoft.

Should you have a previous version of AREPS installed, the new installation will **NOT** overwrite your EM system database file or project folders. However, the formats of the EM system database and projects have changed with version 3.0. There is a database conversion utility program that will convert an AREPS 2.x database file to the new 3.0 format. This utility program is found on the **Database** submenu item of the **Systems** menu.

Software registration

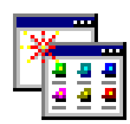
For AREPS 2.0 and later, we have implemented a new program registration policy. This registration policy is analogous to that of shareware programs available from public domain Internet sites. While an unregistered program will have the full functionality of prior versions and future propagation model improvements, a registered program will have access to extended AREPS features. These extended features will be primarily related to tactical decision aids more appropriate to military situations. You may register AREPS by entering your registration number within the InstallShield registration window when you install AREPS, or within the technical support window at any time after AREPS installation.

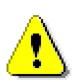
If you are an U.S. government user, you may request your registration number by sending an email to technical support using your valid U.S. government email-address (those with a .gov or .mil extension). A registration number will be returned via email within one working day. If you do not have email access, your may fax, mail, or phone your request to technical support. Your registration number will be mailed to you at your official U.S. government mailing address.

Registration requests from non-U.S. government users will be considered on a case-by-case basis.

Uninstalling AREPS

Should you need to remove the AREPS program, we highly recommend you use the Add/Remove program icon found in the Windows Control Panel and let the Install Shield uninstall program remove AREPS for you.





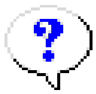
Other programs may need some system files. The Install Shield uninstall program will alert you as to which files these are and will ask for your permission to remove them. If in doubt, it is best to just leave these files in place.

▶ **To uninstall AREPS**

Steps	Comments
1	Click the **Start** button, point to **Settings**, and then click the **Control Panel** icon.
2	Double click the **Add/Remove Programs** icon.
3	Select AREPS from the installed component list.
4	Click the **Add/Remove** button.

AREPS Support Services

On-line Help



If you have a question about AREPS, first look in the printed documentation, consult on-line Help, or use the Help Step feature. Each input parameter, menu item, program option, or window has its own on-line help that defines or describes the parameter and any special considerations, cautions, and proper parameter uses. The on-line help is in two forms; a What's This Help and full help.

▶ **To use the What's This Help feature**

There are two ways to access What's This Help. The first is to select **What's This Help** from the AR

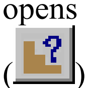
and click on an item within the window.

In some cases, an item may be so self-explanatory that help should not be needed. For these items, clicking on them will cause a "No HELP topic is associated with this item" message to be displayed.

▶ **To use the full help feature**

Select **Help** and then **Contents** from the AREPS main menu bar.

▶ **To use the Help Step feature**

To aid you in learning how to use AREPS, we provide a help steps window, figure 1-1. The window opens by clicking the Help Step () toolbar button. The help steps lead you through the data entry and execution process.

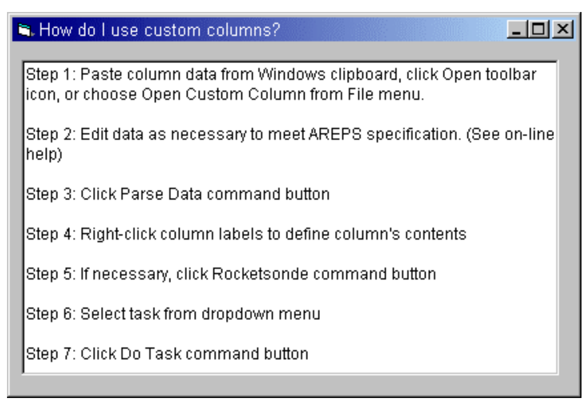
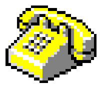


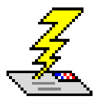
Figure 1-1: Help steps window.

Technical Support

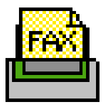
We provide no-charge support for AREPS, including help with software-related problems or questions and training and consultation in the proper use of the AREPS products. Support is available between 7:15 a.m. and 4:45 p.m. Pacific Time, Monday through Thursday, excluding holidays. Our working hours are such that every other Friday is a non-working Friday. Should you call on the non-working Friday, you may leave a message and a developer will return your call as soon as possible.



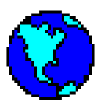
For technical support via a toll call, dial (619) 553-1424; or via the Defense Switching Network (DSN), dial 553-1424.



For technical support via the Internet, electronically mail your questions to areps@spawar.navy.mil.



For technical support via facsimile, dial (619) 553-1417.



As additional capabilities are implemented or software problems are discovered and resolved, service packs will be posted on our Internet homepage. To obtain the latest service pack, to request the complete AREPS program, to view other people's questions or ask your own, and to receive other announcements via the Internet, point your browser to our homepage at http://sunspot.spawar.navy.mil.

Error Messages

A number of situations will arise where AREPS needs to communicate with you. This happens in the error and message-handling window. The window has a title, a menu system, an icon, a short description of what AREPS is trying to do, a text area, and one or more command buttons depending upon the nature of the error or message.

Error and **Message Window - Description and Solution**

Within the text area of the error and message window, figure 1-2, is a section labeled description and a section labeled solution. The description message, colored red, explains what error occurred or provides other information concerning the operation of AREPS. The solution message, colored blue, provides either a recommendation to resolve the error or asks you to make a decision about how to proceed.

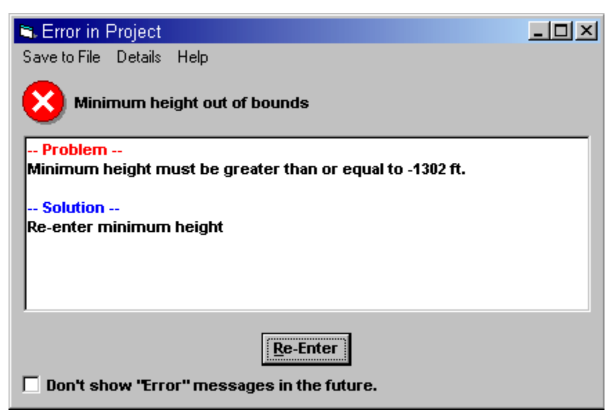


Figure 1-2: Error window - description view.

Error and Message Window - Icons

The error window shows an icon depending upon what type of error occurred. These are:

Icon	Message type
	An informational message. In most cases, there will be a single OK command button.
	A request for additional information. There may be a single OK command button, a Yes and No command button, a Continue command button, or some other decisions command button depending upon the question.
	A warning of a questionable input or an inadvisable action. If your input is not recommended but still allowed, you will have an Accept and a Re-Enter command button. If your input is not acceptable, you will only have a Re-Enter command button.
	Because we all make mistakes, sometimes an error will happen that prevents AREPS from continuing. This is called a critical error. Critical errors happen because something unexpected (but still anticipated) has occurred. For example, you may delete a needed file external to AREPS. When AREPS tries to use the file, a critical error will occur. In some cases, you are given suggestions on how to resolve the problem. In other cases, you will be advised to contact the AREPS technical support team.

Error and Message Window - Details

By selecting “Details” from the error and message window menu, figure 1-3, the description/solution text will be replaced with complete details of the AREPS program, the location in code where the error occurred, and your computer’s environment. This information is useful to the technical support team in resolving your error. In this view, the “Details” menu item will change to “Description” so you may return to the description and solution text.

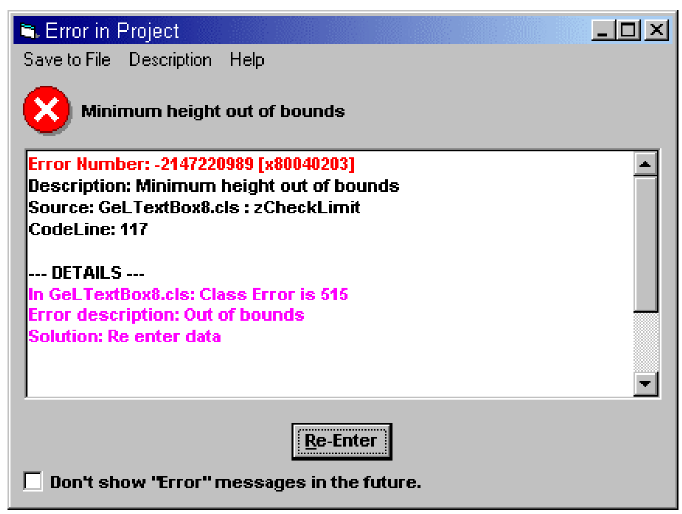


Figure 1-3: Error window - details view.

Error and Message Window - Menu System

Along the top of the error and message window is a menu system, figure 1-4, designed to assist you in your

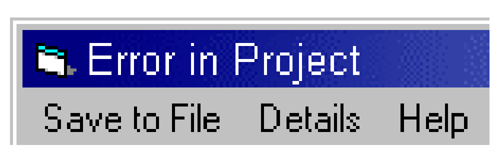


Figure 1-4: Error window menu system.

understanding of AREPS and to assist the technical support team in providing quality support.

The “Save to File” menu item allows you to save detailed error, AREPS, and system information to a file which you may, in turn, email to technical support to aid us in resolving an unexpected error (such as a runtime error). The “Details” menu item will show the details. The “Help” menu item will open the on-line help for the topic appropriate to the error or discussion.

Error and Message Window - Command Buttons

Depending upon the nature of the error or message, one or more command buttons will be displayed in the error and message window. The button captions should be self-explanatory and are shown in figure 1-5. Simply click the appropriate button to either resolve the error or make a decision.

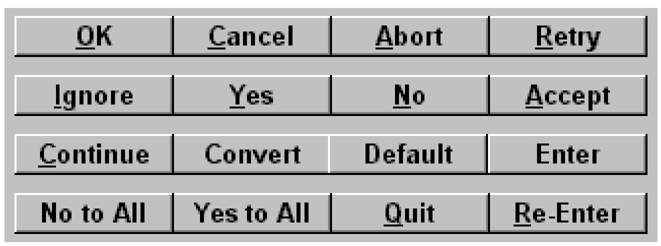


Figure 1-5: Error window command buttons.

Runtime Errors

In a perfect world, software would run flawlessly. Sometimes however, the critical error will not only be unexpected but unanticipated. These errors are called runtime errors and will cause AREPS to quit less than gracefully. While we have made every attempt to recognize the common runtime errors and present them in the message window, AREPS does not “trap” on all runtime errors. Doing so would cause AREPS to dramatically slow down. Should one of these runtime errors evade our notice, it will be announced in a system error window. Currently your only solution to a runtime error is to contact technical support.

APM errors

To simplify the integration of the Advanced Propagation Model into future tactical application software packages, we have placed it within a stand-alone dynamic link library. Thus, any such software package becomes responsible for the model’s initialization. Because we will not know if the initialization is correct, APM contains a number of its own internal data input checks and error messages. For example, the AMP error –10 is "Beamwidth is less than or equal to zero for directional antenna pattern." The AREPS program makes these input checks itself prior to the APM initialization. However, there may be a case when an APM error still occurs. Should this happen, the APM problem and solution is shown in the normal error window. Should you try the suggested solutions and the APM still fails, please contact technical support.

Debug window

In order to provide better customer support, our software is designed with an internal debugging capability, figure 1-6, that will create a history of your keystrokes, mouse clicks, subroutine calls, computational activities; and other information such as your machine and graphics settings. By using this history, the technical support team is able to isolate a line of code that may have caused an error.

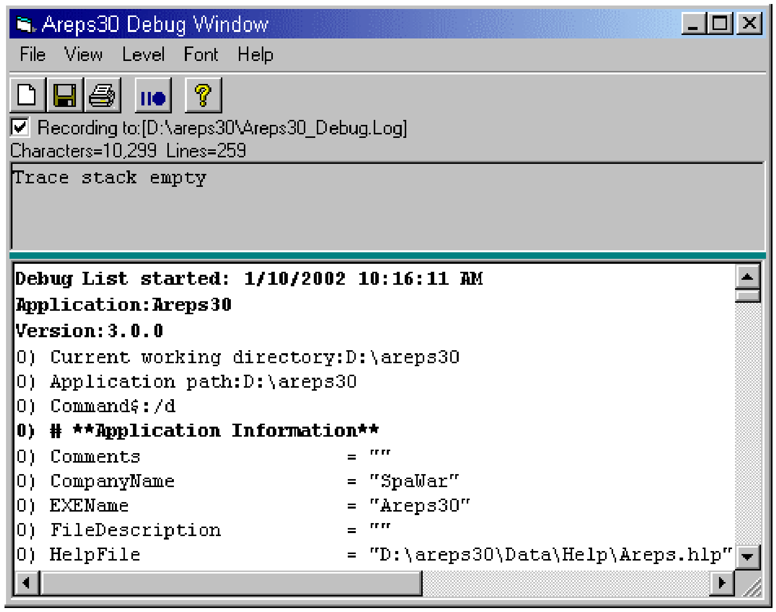


Figure 1-6: Debug window.

By default, this capability is turned off. However, you may turn it on using the instructions provided you by the technical support team. Once turned on, this history shows within the debug window.

Using the toolbar icons, you may clear the history, save the history to a file that then may be e-mailed to technical support for evaluation, print (either in total or just a part of) the history, start and pause the history recording, and obtain help. Please contact technical support for guidance on how to use the debug window. These toolbar functions are also available from the window's menu system. In addition, the menu system allows you to change the **Level** of recording details, change the **Font** of the window, and change the **View** of the toolbar.

How to Run the AREPS Program

Steps	Comments
1	Start AREPS by double clicking the AREPS start menu item or by clicking the Windows **Start** button, clicking the **Run** button, and typing the *AREPS.EXE* file name in the run field.
2	If running AREPS for the first time, complete the program initialization information.

Steps	Comments
3	If running AREPS for the first time, populate your EM system database. Additional EM systems may be entered into the database at any time.
4	Enter the atmosphere's current refractive conditions or create an environmental file from climatology.
5	Create a new project or select a previously created project. Edit the project as necessary.
6	Click the **Execute** command button.

Navigating the AREPS Windows

Across the top of the AREPS program's main window, figure 1-7, is a menu system that controls all the program's functionality such as creating decision aids, editing data input, viewing toolbars, performing EM system database management functions, creating and displaying environmental data, setting program options, and obtaining help. All windows are opened, closed, and otherwise managed from the menu.

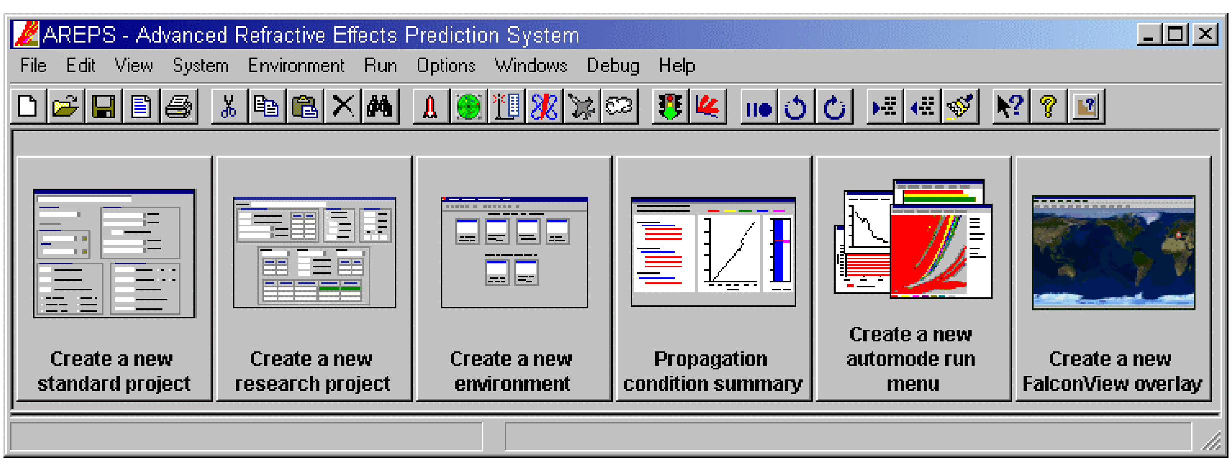


Figure 1-7: AREPS main window.

Below the menu system is a toolbar with icons that mirror the functionality of the menu system. The menu and toolbar system applies to all windows. AREPS automatically recognizes your active window and adjusts the menu text and toolbar functionality accordingly. Any menu or toolbar function that is not appropriate for your active window will be disabled. You have access to the menu and toolbar system at any time, except for when the Options windows and the Error window are opened. These windows require you to make a critical decision before the program can proceed.

At the bottom of the main window is a status bar. The status bar is divided into three panels. The left panel provides limit information about the input item that currently has your attention. The right panel provides information about how to select an item or other program status situations. The center panel shows the time consumed for certain calculations.

In the middle of the main window is a number of large quick action buttons. Rather than using the menu system, you may simple click on one of these buttons to perform the task as labeled on the button.

All other AREPS windows contain a combination of data input points (controls) which gain focus when they are accessed. You use these input points to provide any necessary data. At the top of each window is a title bar describing the window's type. Since Windows is capable of multi-tasking, more than one window of the same type may be open at the same time; for example, you may have three radar windows open simultaneously. If so, the window's number shows in the title bar as Element(0), Element(1), etc. You have access to the AREPS menu system at any time, except when the Options window and the Error window are open. These two windows require you to make a critical decision before AREPS can proceed.

Entering or Editing Data

A flashing cursor for text fields or a highlighted background for other controls shows the item that has the focus. An instructional prompt for this item shows in the status bar. For a text field, when the field first gains your attention, the text will be highlighted. While highlighted, the DELETE key will erase the contents of the field. If the text is not highlighted, the DELETE key will erase only the character to the right of the cursor. To input or edit data, just type a new value. Once any change is made to a field, the highlight will disappear. The ← and → keys move the cursor to the left and right within the field. The ↑ and ↓ keys move the cursor up and down within a tabular form. It is not necessary to press the ENTER key before moving to another field.

Data Limits

An error checking convention applies to all input fields. AREPS assigns limits to most input items. The limits are divided into two groups, a hard limit group and a soft limit group. Hard limits are limits that you may not exceed and AREPS will not accept. Soft limits are limits that we consider to be out of the normal usage range but will still allow you to enter. If you exceed a hard limit, the background color of the input value will turn to red. If you exceed a soft limit, the background color of the input value will turn yellow. While you may move about a window with a limit violation, you will not be allowed to save a system or execute a project with a hard limit violation. Figures 1-8 and 1-9 are illustrations of these two error conditions.

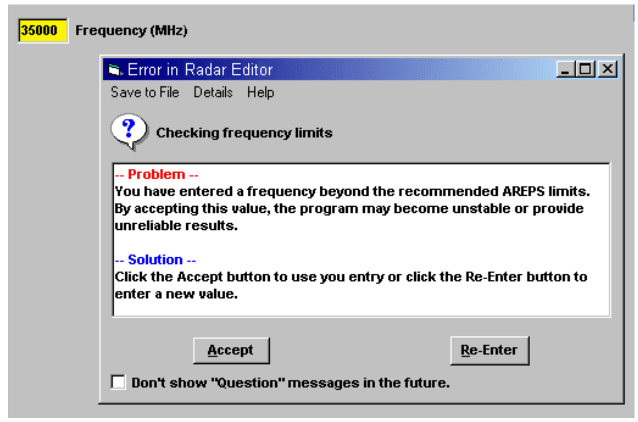


Figure 1-9: Soft limits violation window

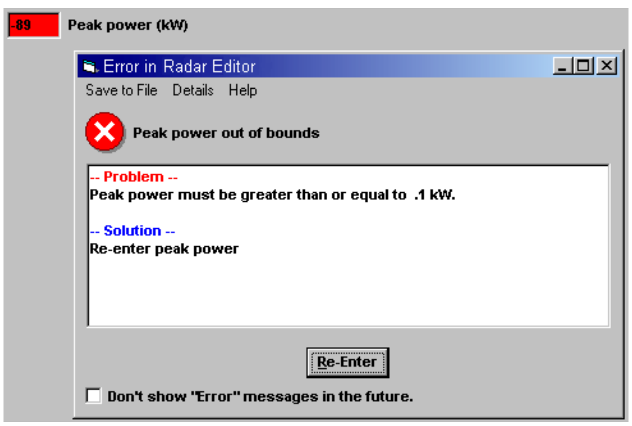
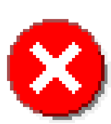


Figure 1-8: Hard limits violation window.



A value outside the valid range may yield erroneous BUT NOT NECESSARILY OBVIOUSLY WRONG results and may cause AREPS to abort with a runtime error, may cause loss of computer memory, or may cause some other undesirable consequence. You are encouraged to adhere to the recommended limits when entering a value.

Changing Units

All allowable units are preprogrammed and you may not deviate from them. Units may be changed by typing the first letter of the desired unit in the input field, or by clicking the right mouse button on the information label appearing adjacent to the field. For items within a tabular form, you may click the right mouse button on the column's title bar.

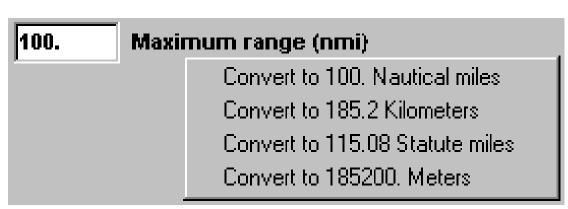
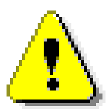


Figure 1-10: Units selection popup menu.

For a right mouse click, a unit's selection popup menu, figure 1-10, appears. Highlight your choice with the ↑ and ↓ keys and press the ENTER key, or click on your choice with the left mouse button.

When you change units, the value may or may not be converted. By default, the value is not converted. You may change the default by selecting the **When changing units, also convert the value** check box from the **Program flow** item on the **Options** menu. If you have this option set, the popup menu will also show the converted value so you may see what it is before the actual conversion takes place.

More than one field may be "tied" to a particular unit, especially for items in a tabular form. Converting such a field will convert ALL fields tied to that unit. For example, when entering pressures in the Environment window, changing any pressure from millibars to inches of mercury will cause all pressures to be converted. For the Environment window, changing units without converting the values will cause the calculated height versus *M*-unit profile to become a whole new profile. By changing the units and converting the values, the profile remains the same.



When values are converted, they may be rounded with a loss in precision. Converting the value again could compound the rounding error. Therefore, changing back to the original units may not convert the value back to its original value. USE THE CONVERT UTILITY WITH CARE.

Unit conversion utility program

As a convenience, AREPS provides a handy unit conversion utility program, figure 1-11. This program is reached from the Windows menu. To use it, choose the unit conversion type from the dropdown menu, enter a number into the **From** input field, right click the labels adjacent to the **From** and **Result** input field to select the desired units, and then click the Convert button. For some conversions, an additional input is required. If so, the proper input field will become visible. The conversion is shown in the **Result** field. In the sample picture below, the conversion is from relative humidity to dewpoint temperature. The relative humidity is entered as 50%, the additional input of air temperature is entered as 15 º Celsius, and the conversion gives a dewpoint temperature of 4.7 º Celsius.

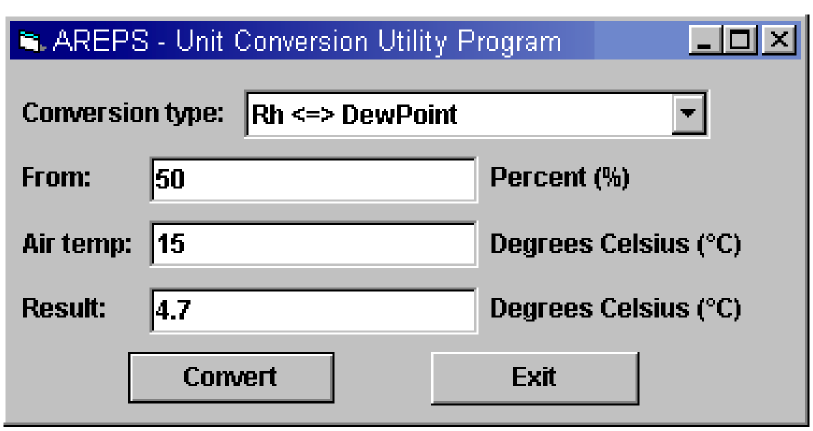


Figure 1-11: Unit conversion utility program.

Initializing AREPS

Upon starting AREPS for the first time, an initialization window, figure 1-12, opens showing the proposed AREPS folder structure (see chapter 2 for a discussion of the AREPS folder structure). As the default, AREPS follows the folder conventions of the Common Operating Environment (COE). Simply click the **Continue/Apply** button to accept this structure. Even for non-COE systems, we recommend you keep the default folders. For non-COE systems, if you need to change any of the folder structure, you may enter a new folder name directly into the input field or click the **Browse** button to choose a folder.

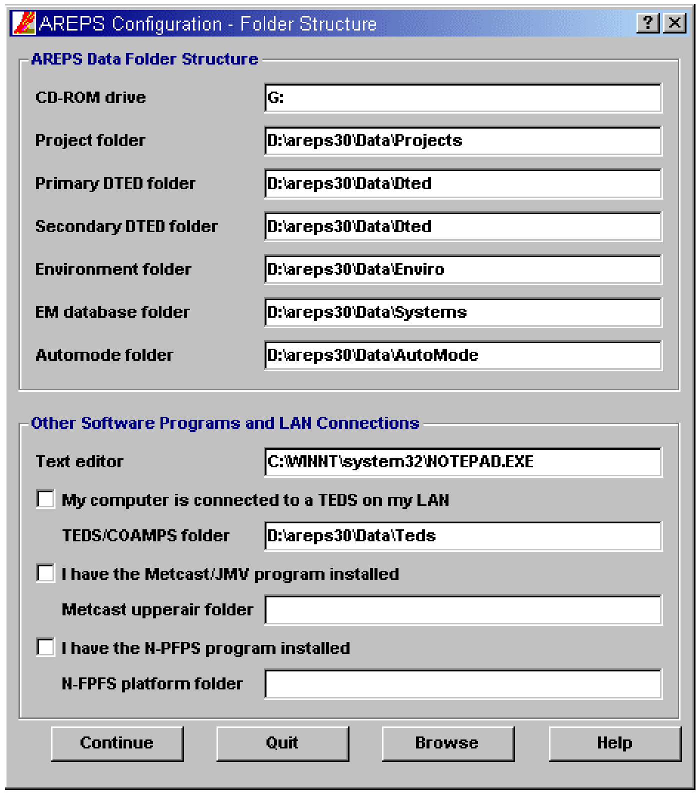


Figure 1-12 AREPS initialization window.

In addition to the AREPS folder structure, there are options for other software programs and local area network (LAN) connections. If any of these options apply to your situation, please provide the additional information.

Should you ever need to change something at a later date, this window may be reached from the **Folders and Drives** item of the **Options** menu.

Continuing will cause AREPS to create an initialization file, which will be used each time you subsequently start the program. Clicking the **Quit** button will cause AREPS to terminate. The name of the file is Areps.ini and always resides in the ini folder.

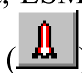
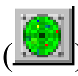
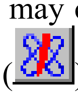
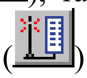
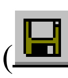
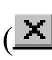
Populating Your EM System Database

If this is your first time running AREPS, you will want to populate your EM system database. There are three ways to populate the EM system database: enter each system individually from the menu system, open an EM system database provided by another agency, or modify your current database using an EM system master database.

U.S. military organizations may contact technical support for additional information about EM system parameters and the EM system master database.

▶ To enter an individual EM system from the system menu.

Follow these steps for each system you wish to enter into the database. For a detailed discussion of each EM system window, refer to chapter 5 (Projects and EM Systems).

Steps	Comments
1	Select **Systems** from the AREPS menu and then **New** Platform, Radar, Target, ESM, or Communication. Optionally, you may click the platform (), radar (), target (), ESM (), or communications () toolbar buttons. A specialized data input window opens for each system.
2	Enter the necessary data.
3	Select **Save** from the **File** menu or click the **Save** () toolbar button. A Save System window opens allowing you to enter a name for your newly created system.
4	Should you choose to create another system with just a slight variation of data, you may edit the necessary fields and then select the **Save As** item from the **File** menu. The Save/Open System window will open so you may enter a new name.
5	When you are finished, click the **Close** () command button located in the window's upper right corner.

▶ To open an EM system database from another agency.

AREPS can use only one EM system database at a time. By default, the database filename is *ArepsDataBase.txt*. It is located in the Systems folder.

Steps	Comments
1	Select **Systems** from the AREPS menu, then select **Database Utilities**, and then select **Open An Existing Database**.

Steps	Comments
2	The Explorer window will open, allowing you to enter a file name. Please note the database file from the providing agency may not be named *ArepsDataBase.txt*.
3	Using the Explorer window controls, locate the desired database file and click the **Open** button.

▶ **To modify your working database from a master database.**

During the AREPS installation, you may choose to have a sample EM system database created. This database becomes your current working database. For detailed instructions on modifying your current working database from a master database, refer to chapter 5 (Projects and EM Systems).

Creating the Current Atmosphere's Condition

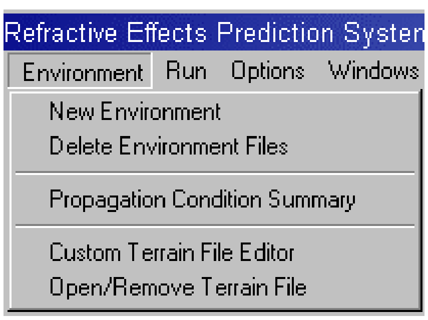


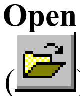
Figure 1-13 Environment menu.

Prior to creating or executing a project, you need to create at least one height versus *M*-unit profile environment file. Select **Environment** from the AREPS menu, figure 1-13 and then select the **New Environment** menu item. Refer to chapter 7 (The Environment) for a complete discussion on each creation method.

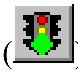
As a convenience, AREPS comes with several sample atmosphere files from which to choose.

Creating and Running a Project

Select either **New Project** or **Open Project** from the **File** menu.

Optionally, you may click the Open () toolbar button or click the **Create a new standard project** quick start command button.

A project window opens, allowing you to specify the radar, platform, target, ESM receiver, communications system, environment, location, bearing(s), and maximum range and height and axis display options. For a complete discussion of the project window, refer to chapter 5 (Projects and EM Systems).

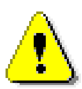
After the project information is entered, select the **Execute** item from the **Run** menu or click the **Execute** () toolbar button. This action saves the current project information and begins computations.

If the project requires terrain not previously copied from DTED CD-ROMs, you are asked to insert the appropriate DTED CD-ROMs into the CD drive. You may skip the CD-ROMs should they not be available, or you may select **Terrain** from the **Options** menu to specify the name of a file containing your own terrain data. If DTED terrain files are used, they are copied to the hard drive and a full-circle or wedge terrain map is (optionally) created. AREPS creates a terrain profile for each azimuth and then executes the Advance Propagation Model (APM) program to generate the appropriate coverage diagram.

After all the diagrams are created, AREPS displays the coverage diagrams in sequence. Refer to chapter 9 (Decision Aids) for a further discussion of decision aid options and displays.

Starting AREPS with a command line argument

While not the usual way to start AREPS, it may be started using one or more optional command-line arguments. These arguments allow AREPS to run in different modes depending upon your needs. You may use as many arguments are your require.



We do not recommend you use command-line arguments unless you know exactly what you are doing or have been given instructions by the technical support team.

The usage of these command-line arguments is

AREPS.EXE [/d] [/ns]
[/i File or /if PathFile]
[/p ProjectName or /pf ProjectPathName]
[/a[e] AutoName | /m]

You do not need to enclose the arguments within the square brackets []. There must be a space between each argument, its modifier (if there is one), and a subsequent argument. For example, if you want the /d and /pf arguments, the usage is

AREPS.EXE /d /pf ProjectPathName

These arguments perform the following functions

Argument	Purpose
/d	Start AREPS in the debug mode. This mode allows the technical support team to observe the internal workings of the program in addition to your AREPS program and computer settings. We strongly recommend you do not use the debug mode unless asked to do so by the technical support team, as this mode will add significantly to AREPS runtimes.
/ns	Start AREPS without showing the splashscreen picture.
/i File	Starts AREPS with the initialization file "File" where the "File" exists in the areps30/data/ini folder. This file is used in place of areps.ini.
/if PathFile	Starts AREPS with the initialization file "PathFile" where the "PathFile" is the full path specification of the initialization file. This file is used in place of /areps30/data/ini/areps.ini.
/p ProjectName	Starts AREPS with the project "ProjectName" where the "ProjectName" exists in the areps30/data/project folder.
/pf ProjectPathName	Starts AREPS with the project "ProjectPathName" where the "ProjectPathName" is the full specification of the project's initialization file.
/a AutoName	Starts AREPS with the automode project "AutoName" where the "AutoName" exists in the areps30/data/automode folder.
/ae AutoName	Starts AREPS with the automode project "AutoName" where the "AutoName" exists in the areps30/data/automode folder. After the automode is complete, AREPS will end.
/m	This argument may be added to the automode arguments. Using this argument will cause AREPS to operate in a minimized mode. This means that AREPS windows will not appear and the only screen activity that is seen is the AREPS program icon on the Window's task bar.

▶ **To use the command-line start feature**

1. Create a shortcut for AREPS, either on your desktop or within your Windows Start menu system. You may also use the AREPS shortcut that is included within the Start menu by the AREPS installation process.

2. Open the shortcut's properties window and go to the shortcut tab. In the field labeled "Target", change the text to read "C:\Program Files\AREPS\Areps.exe" /argument. Note that the AREPS path must be within quote marks but the /argument is external to the quote marks. If you installed AREPS in some location other than C:\Program Files\AREPS, enter your own path to the areps.exe file.

3. Click the OK button to close the shortcut window. The next time you start AREPS from this shortcut, the command-line argument(s) will become active.

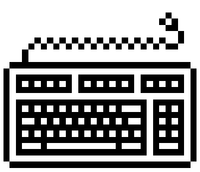
CONVENTIONS, FILES, AND WINDOWS

Terms and Conventions

Typographical Conventions

Formatting convention	Type of information
Triangular bullet (▶)	Step-by-step procedures. Complete the procedural instructions by using either the mouse or the keyboard.
Bold type	Words or characters you type or a menu item you select. For example, if the instructions are to type **run setup**, you type the lowercase letters "run" followed by a space and the lowercase letters "setup."
Italic type	Specialized terms, titles of books or manuals, or placeholders for items you must supply, such as a filename. For example, if the instructions are to type *folder name*, you type the name of the folder.

Keyboard Conventions

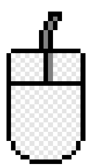


All key names are in capital letters. For example, the Control key is CTRL and the Escape key is ESC. (The keys on your keyboard may not be labeled exactly as used here.)

Keys	Comments
Shortcut keys	Keys frequently used in combinations or sequences as shortcut keys. For example, SHIFT+F1 means to hold down the SHIFT key while pressing the F1 key, and ALT, F, A means press and release each key in order.
RETURN and ENTER	These keys perform the same action in AREPS. In most cases, the ENTER key will move the focus from one data insertion point to another. It is not necessary to press the ENTER key, however, before you move to another item using the mouse.

Keys	Comments
Arrow keys (←, ↑, →, ↓), HOME, END, TAB, SHIFT TAB, PAGE UP, PAGE DOWN	Many navigation keys may be used to move the focus to a data insertion point. Some keys may be used in combinations, such as the CTRL+HOME. Some key combinations, such as the SHIFT+↑, are not available on all keyboards. In some cases, the arrow keys may cause an automatic update feature not to function correctly. If this should occur, use the mouse to select or move to an item.
Numeric keypad keys	If you have an extended keyboard, you can type numbers with the numeric keypad if you first press the NUM LOCK key.

Mouse Conventions



The most efficient method of moving about within AREPS is by using a mouse. You can use a single or multiple-button mouse with AREPS. If you have a multiple-button mouse, the left mouse button is the primary mouse button. Any procedure that requires you to click the secondary button will refer to it as the "right mouse button." Using the center button of a three-button mouse may give unpredictable results.

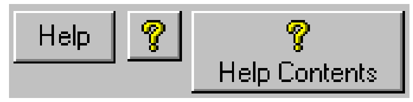
Term	Comments
Point	Position the mouse pointer until the tip of the pointer rests on whatever you want to point to on the screen.
Click	Press and then immediately release the mouse button without moving the mouse.
Double click	Click the mouse twice in rapid succession without moving the mouse.
Drag	Point to an item. Press and hold down the left or right mouse button, and point to where you want the item.

Data Input Conventions

AREPS uses a number of different controls to accept your inputs. These are:

Controls or input point names	Illustration

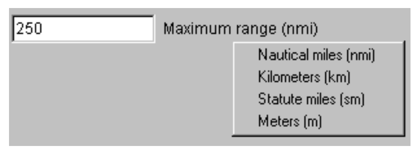
Command button. A command button performs the action stated on the button. The button may have a word or just an image. Left click on the button to cause the action to happen.



Check box. To check or uncheck a box, left click on the box. The ENTER key will also "toggle" the check off and on.

Dropdown menu. For some dropdown menu items, AREPS will perform automatic update functions for you. In these cases, an input field value may change. Be sure you have examined all input fields before proceeding with the program.

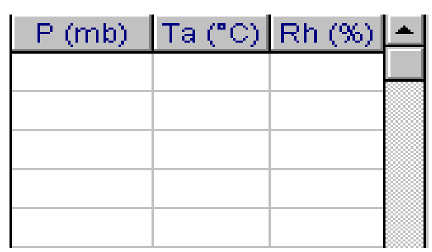
Input field. You are required to type a value into an input field. A field label and units label is generally associated with an input field. The limits of an input field show in the left panel of the status bar. To change units, right click on the field label.



Option button. Option buttons appear in a group. To select an option, left click on the option circle. The arrow keys will also move you between option buttons within the group. Selecting an option button deselects the other option buttons in the group.

Tab. The tab is a way to organize and show many options within the same window. To move between tabs, left click on the tab's label.

Tabular form. The tabular form is just rows and columns of input fields (called cells). If you are in the last cell and press the ENTER key, a new row of cells will be added to the form. The label and units show at the top of each column. To change units for all entries in the column, right click on the label.



Folders and Files

Defense Information Infrastructure – Common Operating Environment

Because AREPS is a segment of the Department of Defense command and control system, it must be a "good neighbor" with other defense software programs. To be a good neighbor, AREPS must meet certain design requirements as defined by the Defense Information Infrastructure – Common Operating Environment (DII-COE). Some of these requirements place restrictions upon AREPS that are more stringent than Microsoft® software design requirements. For example, the DII-COE defines a fixed folder structure vice the free folder structure of non DII-COE software programs. As another example, the DII-COE imposes a more restrictive file naming convention than that used by Microsoft.

In order to maintain only one software source code, AREPS contains an internal flag (defined at the time of AREPS installation) that is used to activate or deactivate certain features. Once installed as a DII-COE compliant software program, non DII-COE features are unavailable.

File name conventions

Windows 95/98/NT/2000 support two types of file naming conventions, a Universal Naming Convention and a long filenames convention.

Universal Naming Convention

The Universal Naming Convention fully describes the location of an object in the system. The format is:

\\server\share\(optionally)path\(optionally)filename.ext

UNC names offer a complete filename specification without having to attach a drive letter. For comparison, in Microsoft MS-DOS the format for a complete filename specification is:

Drive:\directory path\filename.ext

The server portion of the UNC name is limited to 15 characters. The limit for the share name is dependent on the networks. For example, Windows 95/98/NT/2000 share names can accommodate names 260 characters long, but NetBIOS names can only be 15 characters long. UNC names allow you to use network resources the same as local resources. UNC names are used for both the local workgroup and the entire network.

You may use the UNC convention within AREPS to access a shared network resource. For example, you may use the UNC to access the DTED terrain data on another computer within your network. To do so, the shared resource must have full-shared privileges. Please contact the owner of the shared resource for further information.

Long filenames

Long filenames (LFNs) are native to Windows 95/98/NT/2000. They are the default format that the system uses. However, every time a file is created with an LFN, an 8.3 (8 maximum characters in the name, with a 3 character maximum extension) name is automatically assigned.

A LFN may have up to 256 characters, including blank spaces. The path for a file may have up to a total of 260 characters. However, if both path and filename are specified, the total is still only 260 characters. LFNs are not case sensitive. However, they do preserve the case of characters. The excluded characters for LFNs are \, :, *, ?, ", <, >, and |. This program will not allow these excluded characters.

When using long filenames, you should consider the implications. Some utilities will not work with long filenames. These utilities may be virus scanning programs, disk repair utilities, disk optimizers, and other programs dependent on the FAT file system. We recommended the first three or four letters be significant so that the 8.3-filename aliases can be distinguished from each other. You may even want to make the short filename as part of the long filename.

When this program creates files, extension characters are automatically added. For example, when saving an environmental profile, the extension _env.txt is appended to the file name. Therefore, it is not necessary to worry about filename extensions when you are saving files within the program.

If AREPS is installed as DII-COE compliant, additional restrictions are imposed upon the file name convention. For example, long file names are limited to 32 characters and may not contain blank spaces. AREPS will insure these conventions are met.

Folder Structure

AREPS is structured such that it uses a number of folders following the folder conventions of the Common Operating Environment (COE) as illustrated in figure 2-1. The paths to these folders are established when you run the program setup. If you installed AREPS as non-COE, you may change the paths to some of these folders after the setup from the **Folders and Drive** item on the **Options** menu. By default (for non-COE installations), the AREPS main folder is placed under the *Program Files* folder. Under the main folder are 2 subfolders, *bin*, and *data*.

The *bin* folder contains the program's dynamic link library (.dll) files, and any other supporting executable and multimedia files. The path to the *bin* folder may not be changed.

The *data* folder contains a number of subfolders. These are *automode*, *dted*, *enviro*, *help*, *ini*, *projects*, *systems*, *teds*, *terrain*, and *wind*. The *data* folder and its subfolder paths may not be changed if AREPS is installed as COE compliant.

The *automode* folder contains all the automode menus you create through the automode window. This folder may also be on a network drive.

The *dted* folder contains all the DTED data required by the project. Because hard disk access is usually much faster than CD-ROM disk access, as AREPS reads the terrain data from the DTED CD-ROM's, the data are written to this folder. Of course, this folder will grow in size, as more data are required.

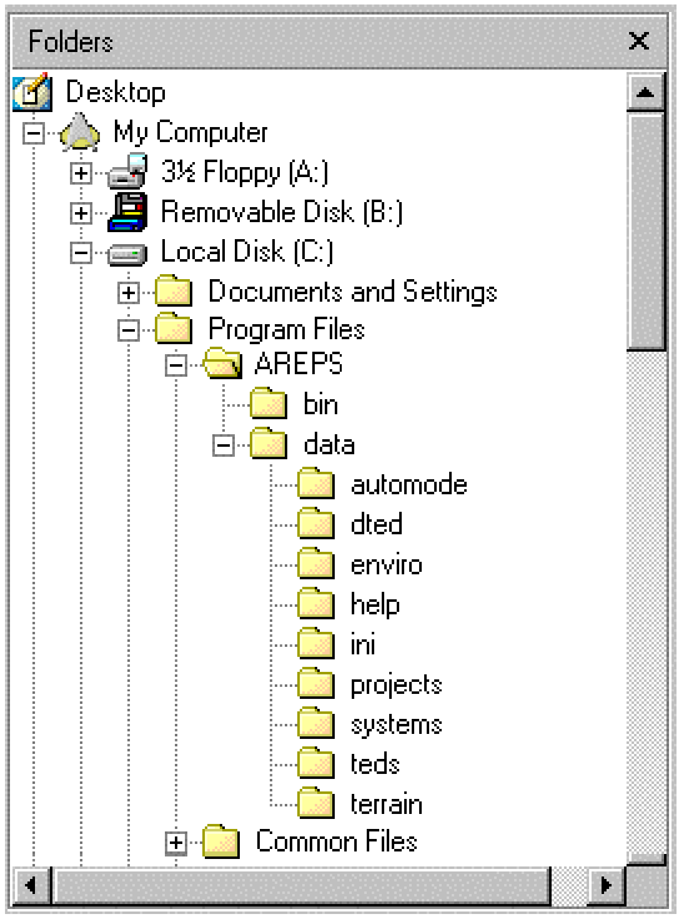
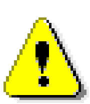


Figure 2-1: AREPS folder stucture.



You are cautioned to watch the amount of disk space available, as low disk space will not only affect the AREPS program but all of your other programs. If time is not a concern, you may want to delete the files within the *dted* folder every so often and let AREPS reread the data as required.

When DTED data are copied from the NIMA distribution CD-ROMs, the file structure on the CD is reproduced on your hard disk. It is important you recognize this file structure, as you will need to reproduce it yourself should you obtain DTED data by downloading it from NIMA's INTERNET or SIPRNET homepage. Refer to chapter 8, Terrain Data, for a complete discussion of the DTED file structure.

Rather than having your own DTED CDs, you may choose to have the DTED folder be a folder on a network drive and let someone else take care of insuring the needed data are available. Since you may not have write permission for the network drive; you can turn off the copying of data from CDs by using the **DTED Terrain** item on the **Options** menu.

The *enviro* folder contains all the refractivity profiles you create through the environment program. This folder may also be on a network drive.

As you create projects, they are saved under the *projects* folder. Each project will become its own subfolder and will contain all the files (except for DTED terrain data) necessary for executing the project.

The *help* folder contains the AREPS on-line help file, table of contents, the user's manual, and other technical documentation.

The *ini* folder contains the program's initialization file. The file is an ASCII text file that may be opened and viewed with any text editor. We recommend you not edit this file external to AREPS but use the various options windows. The path to the ini folder can not be changed.

The *systems* folder contains the Electromagnetic (EM) system database file. The database file is an ASCII text file that may be opened and viewed with any text editor. We highly recommend you do not make any changes to this file external to AREPS but use the Systems menu items instead. This folder may also be on a network drive.

For the convenience of our authorized DoD customers, we are maintaining a master database. The master database may be used to populate your current database. You may request a copy of the master database in serialized correspondence upon official command letterhead. Our master database will only be mailed to command security managers and not to individuals. Please contact technical support for additional details. In addition, authorized users may download our master database from our SIPRNET homepage.

The *teds* folder contains all the environmental data you download from TEDS through the environment program. This folder may also be on a network drive.

The *terrain* folder contains all the terrain files you create through the terrain window. This folder may also be on a network drive.

The *wind* folder contains all the wind files you create through the wind window. This folder may also be on a network drive.

Change folder window

The change folder window, figure 2-2, allows you to browse your disk or any network assets and select a particular folder or CD-ROM drive. Just click on the folder or CD-ROM icon in the tree structure to change a folder. Clicking the OK button accepts your choice. Clicking the Cancel button returns you to your previous input point without a folder choice. Should you select something other than a folder or CD-ROM drive (such as a printer), the OK button will not be available.

If you are selecting a folder or CD-ROM drive on a network asset, that folder or CD-ROM drive must be shared. However, it is not necessary for a networked drive to be mapped. In addition, you may have to contact the network administrator to allow you access to password protected assets.

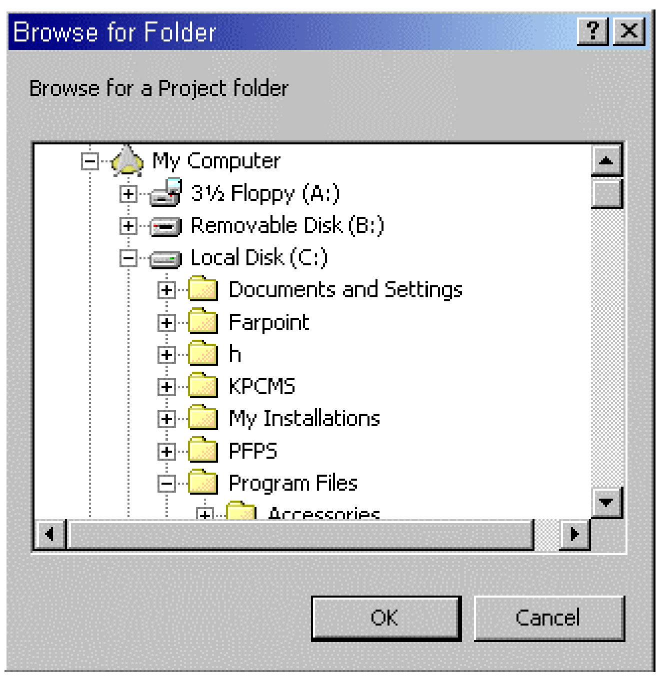


Figure 2-2: Change folder window.

General purpose listing window

There are many places within AREPS where it is possible to get a listing of data. These data appear within the general-purpose listing window, figure 2-3. The window opens by right clicking on an item and selecting it from a popup menu. For example, when you are viewing the contents of your database, right clicking on a system name will open the listing window.

With this listing window, you may save the data as ASCII text, copy the data to the Windows clipboard, or print the data. You may also clear the contents of the listing window and change the text font. Once word of caution about changing the font. Sometimes, the listing window will open with a font capable of showing the data in well-defined columns. By changing the font, the column structure may be lost.

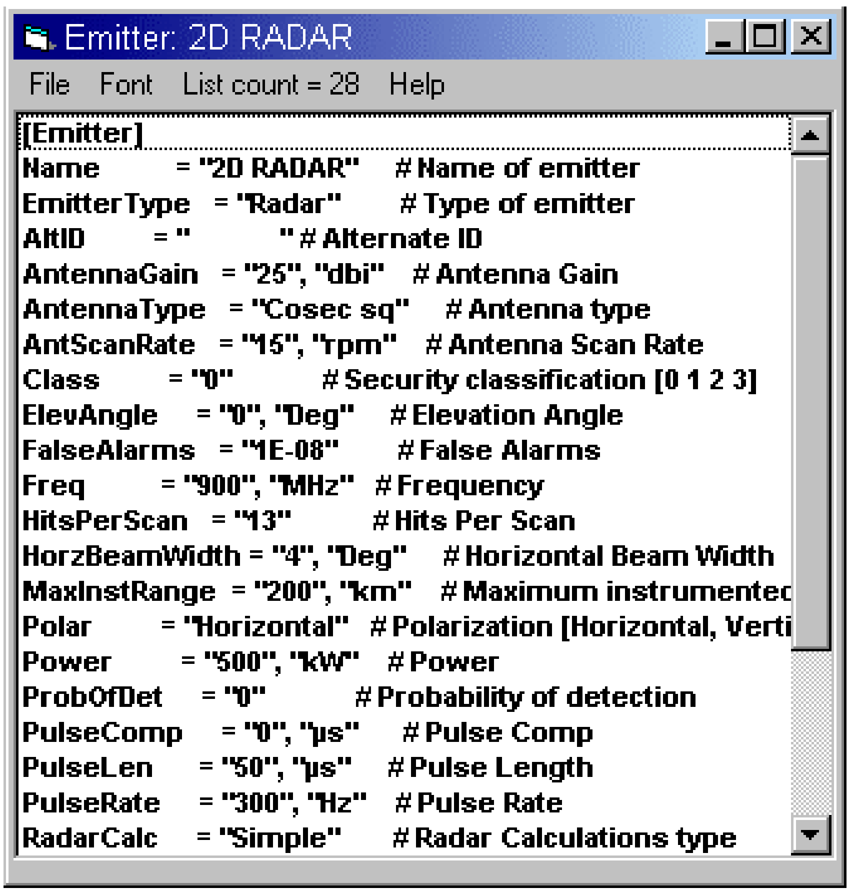


Figure 2-3: General purpose listing window.

Change colors window

AREPS uses many different colors for any different purposes. It is our intention to allow you to change any color you wish. However, changing universal colors is not fully implemented from this first version of AREPS 3.0. You may use the **Project display** item on the **Options** menu to change the colors for the height versus range coverage display.

The environment program also contains a menu item called Colors, which does allow you to change colors universally for that program.

When you want to change colors, the change colors window, figure 2-4, opens in a compact form showing you little color boxes. To select a new color, simply click on the color box you want and then click the **OK** button. If the color you want is not shown in the little boxes, click the **Define Custom Colors** button. The window will expand showing you a rainbow colored box. Click and drag the mouse over the rainbow of colors. As you do, your current color will show in the box labeled Color|Solid. When you have the color you want, click the OK button.

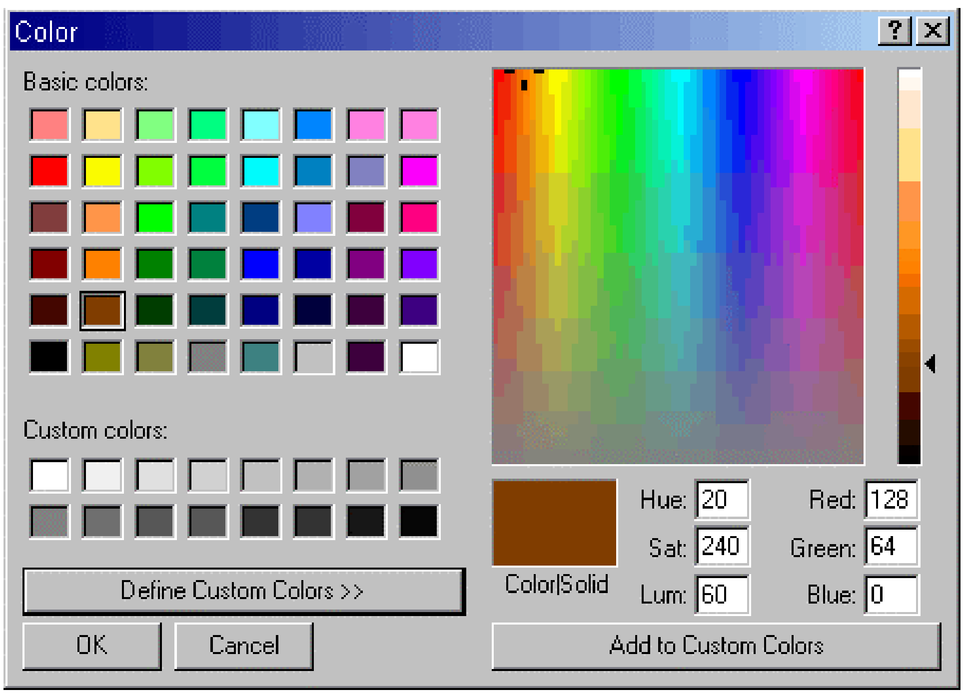


Figure 2-4: Color change window.

THE EARTH'S ATMOSPHERE

Structure and Characteristics

The earth's atmosphere is a collection of many gases together with suspended particles of liquids and solids. Excluding variable components such as water vapor, ozone, sulfur dioxide, and dust, the gases of nitrogen and oxygen occupy about 99 percent of the volume, with argon and carbon dioxide being the next two most abundant gases. From the earth's surface to an altitude of approximately 80 kilometers, mechanical mixing of the atmosphere by heat-driven air currents evenly distributes the components of the atmosphere. At about 80 kilometers, the mixing decreases to the point where the gases tend to stratify in accordance with their weights.

The lower, well-mixed portion of the atmosphere is called the homosphere, while the higher, stratified portion is called the heterosphere. The bottom portion of the homosphere is called the troposphere.

The troposphere extends from the earth's surface to an altitude of 8 to 10 kilometers at polar latitudes, 10 to 12 kilometers at middle latitudes, and up to 18 kilometers at the equator. It is characterized by a temperature decrease with height. The point at which the temperature ceases to decrease with height is known as the tropopause. The average vertical temperature gradient of the troposphere varies between 6 and 7 degrees Celsius per kilometer.

The concentrations of gas components of the troposphere vary little with height, except for water vapor. The water vapor content of the troposphere comes from evaporation of water from oceans, lakes, rivers, and other water reservoirs. Differential heating of land and ocean surfaces produces vertical and horizontal wind circulations that distribute the water vapor throughout the troposphere. The water vapor content of the troposphere rapidly decreases with height. At an altitude of 1.5 kilometers, the water vapor content is approximately half of the surface content. At the tropopause, the content is only a few thousandths of what it is at the surface.

In 1925, the International Commission for Aeronavigation defined the international standard atmosphere. This is a hypothetical atmosphere having an arbitrarily selected set of pressure and temperature characteristics that reflect an average condition of the real atmosphere.

Refraction

Index of Refraction

The term refraction refers to the property of a medium to bend an electromagnetic wave as it passes through the medium. A measure of the amount of refraction is the index of refraction, n, defined as the velocity, c, of propagation in free space (away from the influence of the earth or other objects) to the velocity, v, in the medium. This is

$$n = \frac{c}{v}. \tag{3-1}$$

Refractivity and Modified Refractivity

The normal value of the refractive index, n, for the atmosphere near the earth's surface varies between 1.000250 and 1.000400. For studies of propagation, the index of refraction is not a very convenient number, therefore a scaled index of refraction, N, called refractivity, has been defined. At microwave frequencies and below, the relationship between the index of refraction n and refractivity N for air that contains water vapor is given as

$$N = (n-1)10^6 = \frac{77.6}{T} + \frac{e_s\, 3.73 \cdot 10^5}{T^2} \tag{3-2}$$

where e_s is the partial pressure of water vapor in millibars or

$$e_s = \frac{rh\ 6.105\ e^x}{100}\quad , \tag{3-3}$$

$$x = 25.22\frac{T-273.2}{T} - 5.31\log_e\left(\frac{T}{273.2}\right) , \tag{3-4}$$

$p =$ atmosphere's barometric pressure in millibars,
$T =$ atmosphere's absolute temperature in Kelvin, and
$rh =$ atmosphere's relative humidity in percent.

Thus, the atmospheric refractivity near the earth's surface would normally vary between 250 and 400 N-units.

Since the barometric pressure and water vapor content of the atmosphere decrease rapidly with height while the temperature decreases slowly with height, the index of refraction, and therefore refractivity, normally decreases with increasing altitude.

As a tool in examining refractive gradients and their effect upon propagation, a modified refractivity, defined as

$$M = N + 0.157\, h \quad \text{for altitude } h \text{ in meters and} \tag{3-5}$$

$$\mathrm{M} = \mathrm{N} + 0.048\ \mathrm{h} \quad \text{for altitude h in feet,} \tag{3-6}$$

is often used in place of the refractivity.

Refractive Conditions

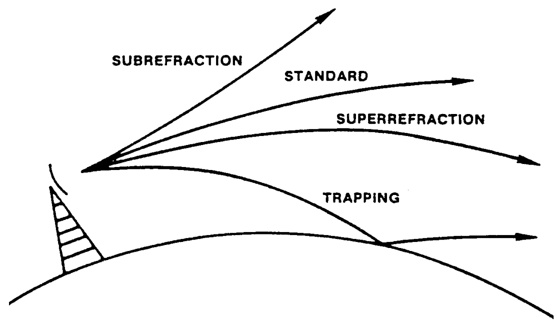


Figure 3-1: Refractive conditions.

Figure 3-1 illustrates the four refractive conditions as discussed below.

Standard and Normal Conditions

The refractivity distribution within the atmosphere is nearly an exponential function of height. The exponential decrease of N with height close to the earth's surface (within 1 kilometer) is sufficiently regular, however, to allow an approximation of the exponential function by a linear function. This linear function is known as a *standard* gradient and is characterized by a decrease of 39 N-units per kilometer or an increase of 118 M-units per kilometer. A standard gradient will cause traveling EM waves to bend downward from a straight line. Gradients that cause effects similar to a standard gradient but vary between 0 and -79 N-units per kilometer or between 79 and 157 M-units per kilometer are known as *normal* gradients.

Subrefractive Conditions

If the motions of the atmosphere produce a situation where the temperature and humidity distribution create an increasing value of N with height, the wave path would actually bend upward and the energy would travel away from the earth. This is termed *subrefraction*. Although this situation occurs infrequently in nature, it still must be considered when assessing electromagnetic systems' performance.

Superrefractive Conditions

If the troposphere's temperature increases with height (temperature inversion) and/or the water vapor content decreases rapidly with height, the refractivity gradient will decrease from the standard. The propagating wave will be bent downward from a straight line more than normal. As the refractivity gradient continues to decrease, the radius of curvature for the wave path will approach the radius of curvature for the earth. The refractivity gradient for which the two radii of curvature are equal is referred to as the critical gradient. At the critical gradient, the wave will propagate at a fixed height above the ground and will travel parallel to the earth's surface. Refraction between the normal and critical gradients is known as *superrefraction*.

Trapping Conditions

Should the refractivity gradient decrease beyond the critical gradient, the radius of curvature for the wave will become smaller than the earth's curvature. The wave will either strike the earth and undergo surface reflection, or enter a region of standard refraction and be refracted back upward, only to reenter the area of refractivity gradient that causes downward refraction. This refractive condition is called trapping because the wave is confined to a narrow region of the troposphere. The common term for this confinement region is a tropospheric duct or a tropospheric waveguide. It should be noted that a tropospheric waveguide is not a waveguide in the true sense of the word because there are no rigid walls that prevent the escape of energy from the guide.

The refractivity gradients and their associated refractive conditions are summarized in table 3-1.

Table 3-1: Refractive gradients and conditions.

Condition	*N*-Gradient	*M*-Gradient
Trapping	< -157 *N*/km or < -48 *N*/kft	< 0 *M*/km or < 0 *M*/kft
Superrefraction	-157 to - 79 *N*/km or -48 to -24 *N*/kft	0 to 79 *M*/km or 0 to 24 *M*/kft
Normal	-79 to 0 *N*/km or –24 to 0 *N*/kft	79 to 157 *M*/km or 24 to 48 *M*/kft
Standard	-39 *N*/km	118 *M*/km
Subrefraction	> 0 *N*/km or > 0 *N*/kft	> 157 *M*/km or > 48 *M*/kft

Atmospheric Ducts

A duct is a channel in which electromagnetic energy can propagate over great ranges. To propagate energy within a duct, the angle the electromagnetic system's energy makes with the duct must be small, usually less than 1 degree. Thicker ducts in general can support trapping for lower frequencies. The vertical distribution of refractivity for a given situation must be considered as well as the geometrical relationship of transmitter and receiver to the duct in order to assess the duct's effect at any particular frequency.

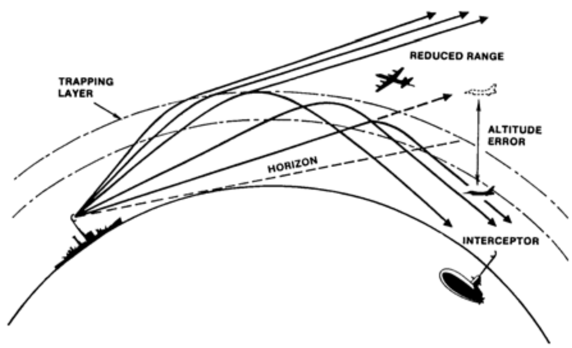


Figure 3-2: Ducting consequences.

Ducts not only give extended radar detection or ESM intercept ranges for systems within the duct, they may also have a dramatic effect upon transmitter/receiver systems that transcend duct boundaries. For example, an air target that would normally be detected may be missed if the radar is within or just above the duct and the target is just above the duct. This area of reduced coverage is known as a radar hole or shadow zone. These ducting consequences are illustrated in figure 3-2.

Although the duct acts like a waveguide for the energy, this waveguide does not have rigid and impenetrable boundaries, except for the earth's surface in cases where the duct's bottom lies at the surface. Therefore, energy is continually leaking from the duct. While the energy level within a radar hole may be insufficient for radar detection, it may be sufficient for ESM intercept of the radar.

In a discussion of ducting conditions upon EM wave propagation, the usual concern is propagation beyond the normal horizon. Within the horizon, however, ducting also has an effect. Ducting can alter the normal lobe pattern caused by the interference of the direct ray and the surface-reflected ray. The relative phase between the direct and reflected path may be changed as well as the relative amplitudes of the two rays. The effect of the duct on the line-of-sight propagation is to reduce the angle of the lowest lobe, bringing it closer to the surface.

Several meteorological conditions will lead to the creation of ducts. Where these conditions exist and what these conditions are will determine the name and nature of the duct.

Surface Ducts

If the meteorological conditions cause a trapping layer to occur, such that the base of the resultant duct is at the earth's surface, a surface duct is formed. There are three types of surface ducts based on the trapping layer's relationship to the earth's surface. The first type is a surface duct created from a surface-based trapping layer. This duct is referred to as a *surface* duct and is illustrated in figure 3-3. The second type of surface duct is created from an elevated trapping layer. This duct is commonly referred to as a *surface-based* duct and is illustrated in figure 3-4. The third type of surface duct is one created by a rapid decrease of relative humidity immediately adjacent to the air-sea interface. This duct is referred to as an *evaporation* duct. Because the evaporation duct is of great importance for over-water EM propagation, it warrants a detailed discussion. This discussion appears in its own section below.

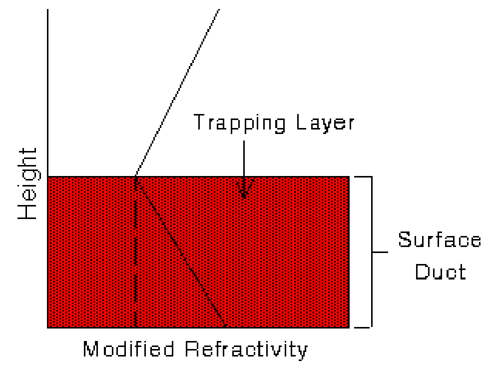


Figure 3-3: Surface duct.

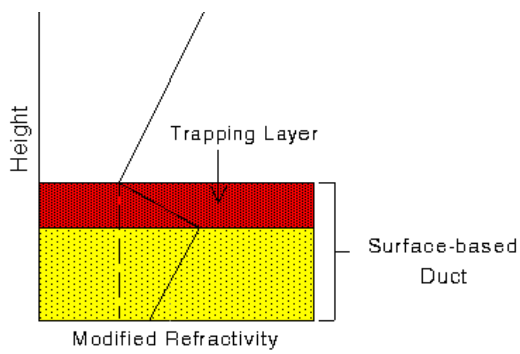


Figure 3-4: Surface-based duct.

Surface-based ducts occur when the air aloft is exceptionally warm and dry compared with the air at the earth's surface. Several meteorological conditions may lead to the formation of surface-based ducts.

Over the ocean and near land masses, warm, dry continental air may be advected over the cooler water surface. Examples of this type of advection are the Santa Ana of southern California, the Sirocco of the southern Mediterranean, and the Shamal of the Persian Gulf. This advection will lead to a temperature inversion at the surface. In addition, moisture is added to the air by evaporation, producing a moisture gradient to strengthen the trapping gradient. This type of meteorological condition routinely leads to a surface duct created by a surface-based trapping condition. However, as you travel from the coastal environment into the open ocean, this trapping layer may well rise from the surface, thereby creating the surface-based duct. Surface-based ducts tend to be on the leeward side of land masses and may occur both during the day and at night. In addition, surface-based ducts may extend over the ocean for several hundred kilometers and may be very persistent (lasting for days).

Another method of producing surface-based ducting conditions is by divergence (spreading out) of relatively cool air under a thunderstorm. While this method may not be as frequent as the other methods, it may still enhance surface propagation during the thunderstorm activity, usually on the order of a few hours.

With the exception of thunderstorm conditions, surface-based ducting is associated with fair weather, with increased occurrence of surface-based ducts during the warmer months and in more equatorial latitudes. Any time the troposphere is well mixed, such as with frontal activity or with high wind conditions, surface-based ducting is decreased.

An interesting feature of surface-based ducts is the skip zone near the normal horizon, in which the duct has no influence. This skip zone is easily illustrated using AREPS (see chapter 10, hardware maintenance tactical application for an illustration) or a raytrace program such as RAYS within the EREPS suite of software programs. It should be noted that the surface duct created from a surface-based trapping layer does not have this skip zone phenomenon.

Evaporation Ducts

As can be seen from the equation for refractivity, a change in the moisture distribution without an accompanying temperature change can also lead to a trapping refractivity gradient. The air in contact with the ocean's surface is saturated with water vapor. A few meters above the surface the air is not usually saturated, so there is a decrease of water vapor pressure from the surface to some value well above the surface. The rapid decrease of water vapor initially causes the modified refractivity, *M*, to decrease with height, but at greater heights the water vapor distribution will cause *M* to reach a minimum and, thereafter, increase with height. The height at which *M* reaches a minimum is called the evaporation duct height as illustrated in figure 3-5.

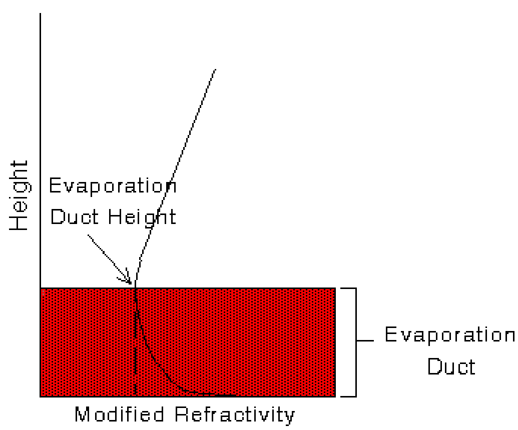


Figure 3-5: Evaporation duct.

Evaporation ducts exist over the ocean, to some degree, almost all of the time. The duct height varies from a meter or two in northern latitudes during winter nights to as much as 40 meters in equatorial latitudes during summer days. On a world average, the evaporation duct height is approximately 13 meters. It should be emphasized that the evaporation duct "height" is not a height below which an antenna must be located in order to have extended propagation but a value that relates to the duct's strength or its ability to trap radiation. The duct strength is also a function of wind velocity. For unstable atmospheric conditions, stronger winds generally result in stronger signal strengths (or less propagation loss) than do weaker winds.

Since the evaporation duct is much weaker than the surface-based duct, its ability to trap energy is highly dependent on frequency. Generally, the evaporation duct is only strong enough to affect electromagnetic systems above 3000 MHz.

Assessment of the evaporation duct is best performed by making surface meteorological measurements and inferring the duct height from the meteorological processes occurring at the air/sea interface. The evaporation duct height cannot be measured using a radiosonde, rocketsonde, or a microwave refractometer. With the advent of newer, high-resolution sondes that may be lowered to the surface from a ship, the impression is given that the evaporation duct may be measured directly. For practical applications, however, this impression is false and a direct measurement should not be attempted. Due to the turbulent nature of the troposphere at the ocean surface, a refractivity profile measured at one time would most likely not be the same as one measured at another time, even when the two measurements are seconds apart. Therefore, any measured profile would not be representative of the average evaporation ducting conditions, the conditions that an assessment system must consider.

The long-term statistical frequency distribution of worldwide evaporation ducts is readily available through our EREPS Surface Duct Summary (SDS) program or our Ducting Climatology Summary (DCS) program. Both of these programs may be obtained from our Internet homepage.

Elevated Ducts

If meteorological conditions cause a trapping layer to occur aloft, such that the base of the duct occurs above the earth's surface, the duct is referred to as an elevated duct as illustrated in figure 3-6.

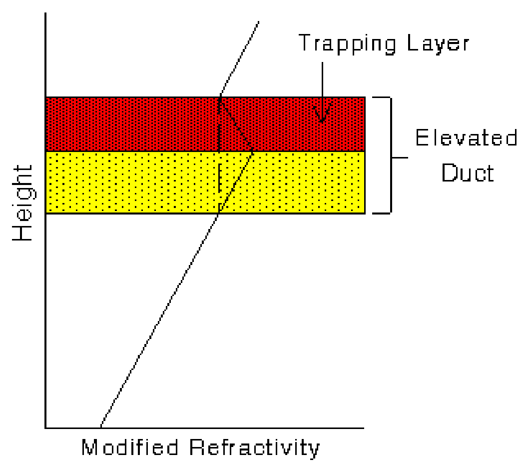


Figure 3-6: Elevated duct.

Great semi-permanent surface high-pressure systems, centered at approximately 30 degrees north and south latitude, cover the ocean areas of the world. Poleward of these systems lay the mid-latitude westerly winds and, equatorward, the tropical easterlies or the tradewinds. Within these high-pressure systems, large-scale subsidence of air causes heating as the air undergoes compression. This leads to a layer of warm, dry air overlaying a cool, moist layer of air (often called the marine boundary layer).

The resultant inversion is referred to as the tradewind inversion and may create a strong ducting condition at the top of the marine boundary layer. Elevated ducts may vary from a few hundred meters above the surface at the eastern part of the tropical oceans to several thousand meters at the western part. For example, along the southern

California coast, elevated ducts occur an average of 40 percent of the time, with an average top elevation of 600 meters. Along the coast of Japan, elevated ducts occur an average of 10 percent of the time, with an average top elevation of 1500 meters.

It should be noted that the meteorological conditions necessary for a surface-based duct are the same as those for an elevated duct. In fact, a surface-based duct may slope upward to become an elevated duct as warm, dry continental air glides over cool, moist marine air. The tradewind inversion may also intensify, thereby turning an elevated duct into a surface-based duct.

Standard Wave Propagation

Propagation Loss and Signal-to-Noise Ratio

AREPS may present its results in terms of propagation loss or radar signal-to-noise ratio. The definitions of each term as used by AREPS are:

Propagation loss: The ratio, expressed in decibels, of the effective radiated power transmitted in the direction of maximum radiation of the antenna pattern to the power received at any point by an omnidirectional antenna. Widely used definitions of path loss are based on omnidirectional antennas. In AREPS, propagation loss is equivalent to path loss when an omnidirectional antenna is specified. Propagation loss is closely related to many definitions of transmission loss. Transmission loss generally includes effects from both an antenna pattern and the absolute gain of the antenna, whereas propagation loss only includes the pattern effects with the gain normalized to 1 (i.e., 0 dB) in the direction of maximum transmission. Therefore, propagation loss would be equal to transmission loss plus the antenna gain in decibels.

Signal-to-noise ratio: The ratio, expressed in decibels, of the signal received at the input of the radar receiver to the noise generated within the receiver itself. For AREPS, the signal level is based upon the reflection from a target of specified radar cross-section, all the engineering parameters of the radar, and the applicable propagation factors.

Standard Propagation

Standard propagation mechanisms are those mechanisms and processes that occur in the presence of a standard atmosphere. These propagation mechanisms are free-space propagation, optical interference (or surface reflection), diffraction, and tropospheric scatter.

Free-space Propagation

The simplest case of electromagnetic wave propagation is the transmission of a wave between a transmitter and a receiver in free space. Free space is defined as a region whose properties are isotropic, homogeneous, and loss-free, i.e., away from the influences of the earth's atmosphere. In free space, the electromagnetic wave front spreads uniformly in all directions from the transmitter.

Optical Interference and Surface Reflection

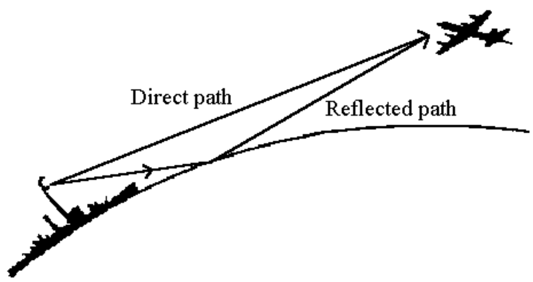


Figure 3-7: Surface reflection.

When an electromagnetic wave strikes a nearly smooth large surface, such as the ocean, a portion of the energy is reflected from the surface and continues propagating along a path that makes an angle with the surface equal to that of the incident wave as illustrated in figure 3-7.

The strength of the reflected wave is determined by the reflection coefficient, a value that depends upon the frequency and polarization of radiation, the angle of incidence, and the roughness of the reflecting surface.

For shallow incidence angles and smooth seas, typical values of the reflection coefficient are near unity (i.e., the reflected wave is almost as strong as the incidence wave). As the wind speed increases, the ocean surface grows rougher and the reflection coefficient decreases. For a transmitter near the surface, the reflection process results in two paths to a receiver within the line of sight.

As stated above, upon reflection, a portion of the energy is propagated in the direction of initial wave motion. A portion of energy is also reflected backward toward the transmitter. This backward reflected energy is also received by the radar and may interfere with the radar's ability to distinguish a desired target. This backward reflected energy is called *clutter*.

Not only is the magnitude of the reflected wave reduced, but the phase of the wave is also altered. For horizontally or vertically polarized waves at low grazing angles, the phase change upon reflection is approximately 180 degrees. Whenever two or more wave trains traveling over different paths intersect at a point in space, they are said to interfere. If two waves arrive at the same point in phase, they constructively interfere and the electric field strength is greater than either of the two component waves taken alone. If the two waves arrive together out of phase, they destructively interfere, and the resultant field strength is weakened.

As the geometry of the transmitter and receiver change, the relative lengths of the direct path and reflected path also change, which results in the direct and reflected wave arriving at the receiver in varying amounts of phase difference. The received signal strength, which is the vector sum of the signal strengths of the direct and reflected wave, may vary up to 6 dB above and 20 dB or more below the free-space value.

Diffraction

Energy tends to follow along the curved surface of an object. Diffraction is the process by which the direction of propagating radiation is changed so that it spreads into the geometric shadow region of an opaque or refractive object that lies in the radiation field. In the earth-atmosphere system, diffraction occurs where the straight-line distance between the transmitter and receiver is just tangent to the earth's surface. For a homogeneous atmosphere, this point of tangency with the earth is referred to as the geometrical horizon. For an inhomogeneous atmosphere (using an effective earth radius) and at radar and optical frequencies, this point of tangency is referred to as the radar and optical horizon, respectively.

The ability of the electromagnetic wave to propagate beyond the horizon by diffraction is highly dependent upon frequency. The lower the frequency, the more the wave is diffracted. At radar frequencies, the wavelength is small when compared to the earth's dimensions, and little energy is diffracted. At optical frequencies or very short radar wavelengths, the optical horizon represents the approximate boundary between regions of propagation and no propagation.

Tropospheric Scatter

At ranges far beyond the horizon, the propagation loss is dominated by troposcatter. Propagation in the troposcatter region is the result of scattering by small inhomogeneities within the atmosphere's refractive structure.

Anomalous Propagation Mechanisms

A deviation from the normal atmospheric refractivity leads to conditions of subrefraction, superrefraction, and trapping as explained earlier. The term anomalous propagation or nonstandard propagation applies to the above listed conditions, but it is most often used when describing those conditions that lead to radar ranges less than or greater than the normal.

Subrefractive Layers

A subrefractive layer of the troposphere would cause the propagating energy to bend upward or away from the earth's surface, thereby leading to decreased detection ranges and shortened radio horizons. Altitude errors for height-finding radars will also become evident in a subrefractive environment.

Subrefractive layers may be found at the earth's surface or aloft. In areas where the surface temperature is greater than 30 degrees Celsius, and relative humidities are less than 40 percent (i.e., large desert and steppe regions), solar heating will produce a very nearly homogeneous surface layer, often several hundreds of meters thick. Since this layer is unstable, the resultant convective processes tend to concentrate any available moisture near the top of the layer. This in turn creates a positive N gradient or subrefractive stratum aloft. This layer may retain its subrefractive nature into the early evening hours, especially if a radiation inversion develops, trapping the water vapor between two stable layers.

For areas with surface temperatures between 10 and 30 degrees Celsius and relative humidities above 60 percent, i.e., the western Mediterranean, Red Sea, Indonesian Southwest Pacific, etc., surface-based subrefractive layers may develop during the night and early morning hours. It is characteristically caused by advection of warm, moist air over a relatively cooler and drier surface. While the N gradient is generally more intense than that described above, the layer is often not as thick. Similar conditions may also be found in regions of warm frontal activity.

Superrefractive Layers

Superrefractive conditions are largely associated with temperature and humidity variations near the earth's surface. Inversions aloft, due to large-scale subsidence will lead to superrefractive layers aloft. Superrefractive layers will lead to an increase of radar detection ranges and extensions of the radio horizon.

The effects of a superrefractive layer upon a surface-based system are directly related to its height above the earth's surface. For airborne systems, the effects of a superrefractive layer depend upon the position of the transmitter and receiver relative to the layer. Both of these factors are related to the electromagnetic wave's angle of layer penetration. The steeper the penetration angle, the less of an effect the layer will have upon propagation.

Trapping Layers

Trapping is an extension of superrefraction because the meteorological conditions for both are the same. While the usual concern is propagation beyond the normal horizon, trapping within the horizon also has an effect. Trapping can alter the normal lobe pattern caused by the interference of energy arriving at a point by the direct path and surface-reflected path. The relative phase between the direct and reflected paths may be changed as well as the amplitudes. The effect on the line-of-sight propagation is to reduce the angle of the lowest lobe, bringing it closer to the surface.

AREPS MENUS

Navigation in the AREPS program is performed with the menu system. Menus may be static and located in bars across the top of a window or may be variable and activated from right clicking on an input control or the window's background. Menu items may be represented by text or by icons. A menu item may be selected either by highlighting it with an arrow key or by left mouse clicking it.

AREPS Main Menu

The AREPS main menu, figure 4-1, is located across the top of the main window.

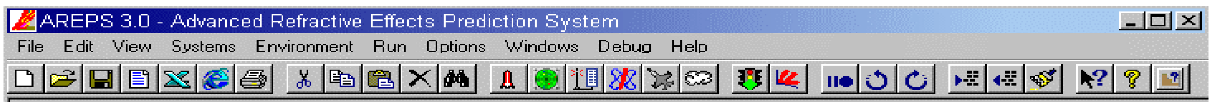


Figure 4-1: AREPS main menu.

The menu items control all the AREPS functionality such as creating decision aids, editing data input, viewing toolbars, performing EM system database management functions, creating and displaying environmental data, setting program options, arranging the AREPS windows and obtaining help.

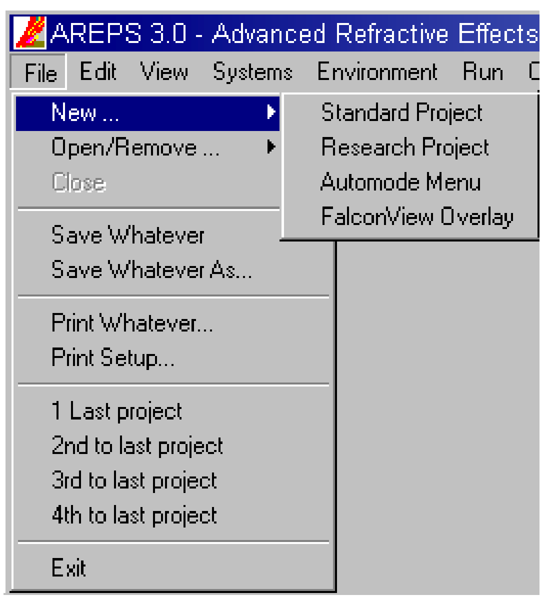


Figure 4-2: File menu.

File Menu

The File menu, figure 4-2, is the starting point for an AREPS project or an automode menu. Projects or automode menus may be created or previously created projects opened or removed with the File menu.

The File menu serves as the Close, Save, and Print point for any active window. For example, if the currently active window is a terrain window, the File menu wording will change to Close Terrain, Save Terrain, and Print Terrain. Likewise, if the currently active window is a radar window, the File menu wording will change to Close Radar, Save Radar, and Print Radar.

The File menu contains a listing of up to four of the last projects you had opened. To reopen one of these projects, either highlight its name with a navigation key and press the ENTER key or just click on its name.

To close the AREPS program, select the **Exit** menu item.

Edit Menu

The Edit menu, figure 4-3, contains all the editing commands for all input fields or tabular forms. You may Cut, Delete, Copy, and Paste data with this menu. Any of these commands may also be undone with the Undo item. The menu items will be active or inactive, based upon which operation is possible. For example, the Insert terrain range and Remove terrain range menu items are active only when the tabular form in the terrain window has the focus.

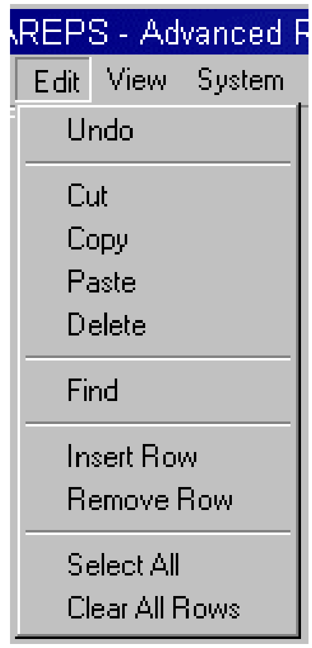


Figure 4-3: Edit menu.

View Menu

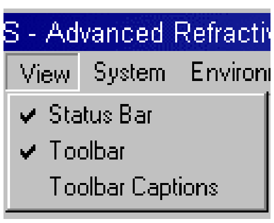


Figure 4-4: View menu.

The View menu, figure 4-4, allows you to make the status bar, toolbar, and toolbar captions visible or invisible. The check mark indicates the particular item is visible.

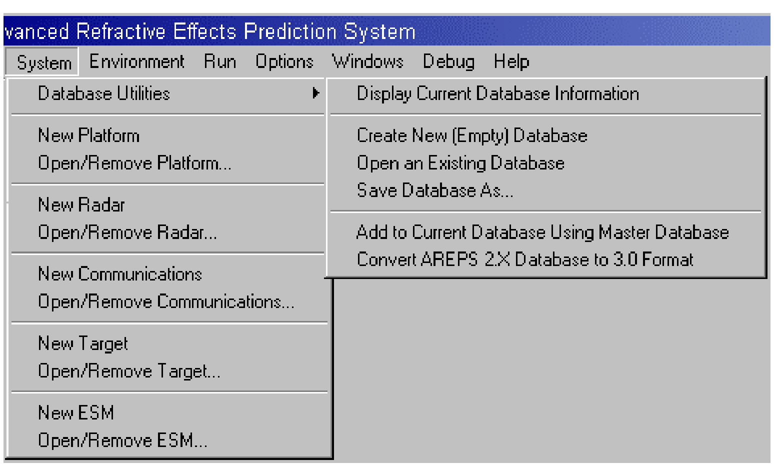


Figure 4-5: Systems menu.

Systems Menu

The Systems menu, figure 4-5, allows you to perform database management functions. You may perform a variety of general database functions in addition to creating, editing, and removing individual systems. Refer to chapter 5, Project and EM systems, for a complete discussion of all the various system menu functions.

Environments Menu

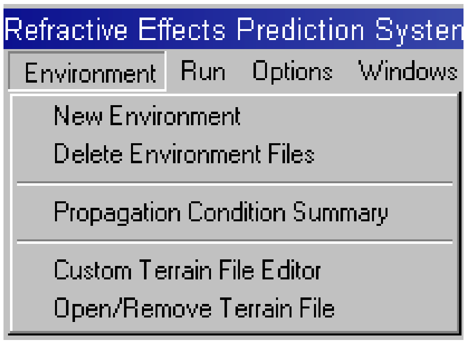


Figure 4-6: Environments menu.

The Environments menu, figure 4-6, is the entry point for creating new environmental input files, deleting environmental input files, creating your own terrain files, or displaying the contents of an environmental file using the propagation summary. Environmental and terrain files are ASCII text files and may also be created externally to the AREPS program.

Refer to chapter 7 (The Environment) for a complete discussion of the various methods for creating new environmental files.

Run Menu

The run menu starts the execution of a project or automode menu or the redisplay of a previously created project. Once a project is executed, you may use the run menu to pause the decision aid rotation and step the decision aid forward and backward in azimuth.

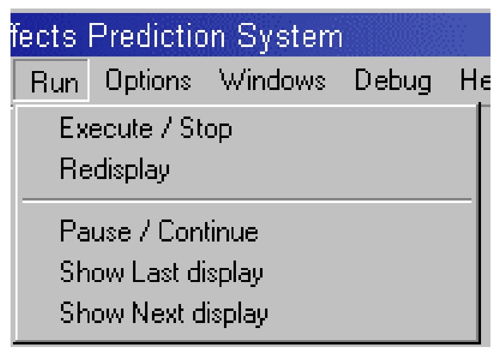


Figure 4-7: Run menu.

Options Menu

Use the Options menu; figure 4-8, to set universal program options and to customize AREPS for your own use. Refer to chapter 6 (Options) for a complete discussion of these various options.

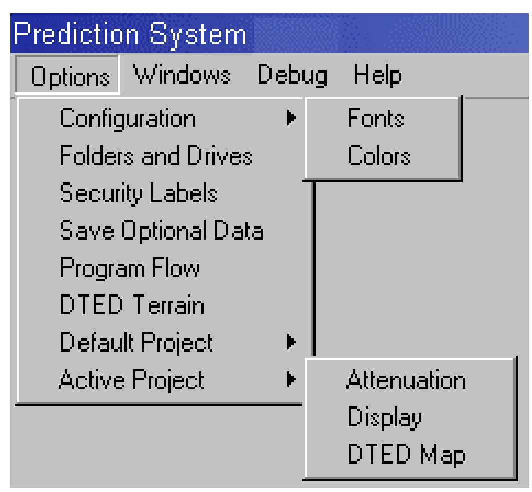


Figure 4-8: Options menu.

Windows Menu

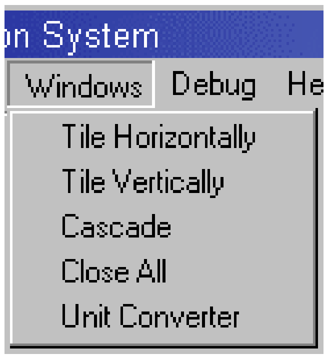


Figure 4-9: Windows menu.

Use the Windows menu; figure 4-9, to specify how you want the AREPS windows to appear on your screen. In addition to appearance options, a list of all the currently opened windows is maintained. The check mark indicates which window is currently active. If you have many windows open at the same time, you may also use the **Close All** menu item to close them all at once.

From the Windows menu, you may also use an unit conversion utility program.

Debug Menu

If AREPS is running in the debug mode, this menu, figure 4-10, will be available. The debug menu is an aid for Technical Support personnel in resolving your AREPS problem. From this menu, you may enable or disable the debug-operating mode, set the DII-COE compliance mode, or view information about AREPS and your operating system. You must contact Technical Support for instructions on how to activate the debug menu.

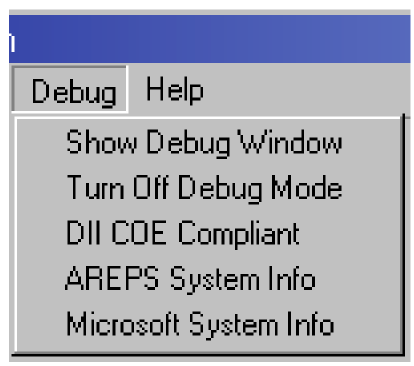


Figure 4-10: Debug menu.

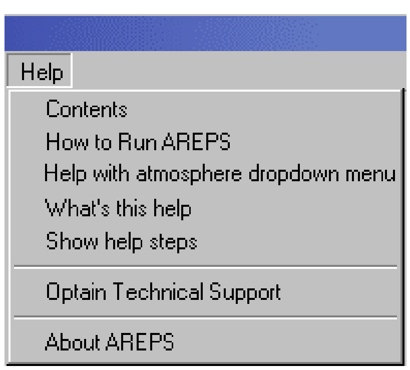


Figure 4-11: Help menu.

Help Menu

The on-line help is also a stand-alone Windows help file. Since it is a stand-alone file, it may also be opened and viewed by double clicking on the *ArepsHelp.hlp* file from the Windows Explorer window.

Use the Help menu; figure 4-11, to access the on-line help with the **Contents** item. **The How to Run AREPS** provides quick information for first time users.

Each data input point has an associated help topic (for example, the atmosphere dropdown menu). The data input point that has your current attention is presented in this help menu. Just select this item from the menu for help on your current topic.

What's this help provides quick access to Help text in a popup window without the need to open the Help viewer. It is typically used to provide simple assistance for user interface elements such as data entry fields.

The **Show help steps** opens a help window that shows step-by-step help in performing a task

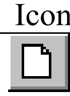
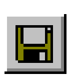
The **Obtain Technical Support** item provides instructions on how to contact the AREPS support team for questions, trouble reports, and other customer service features.

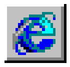
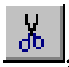
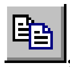
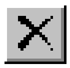
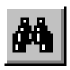
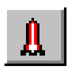
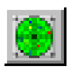
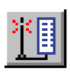
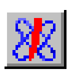
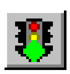
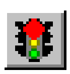
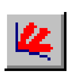
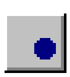
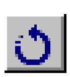
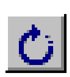
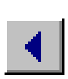
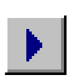
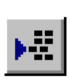
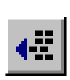
The **About AREPS** item provides information on the current version of AREPS and other general program information.

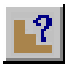
Toolbar menu system

For convenience, AREPS uses a toolbar menu system that duplicates the functions of many main menu items. Consequently, it is not necessary to use the main AREPS menu system for editing and other activities. These toolbar buttons will only be active if their functions are applicable to the current window. For example, if the current window has no text input fields, the cut, copy, and paste buttons will be deactivated. In some cases, a button will serve a dual purpose. For example, the pause record and the start record functions apply to a single button. However, the picture of the button will reflect its current function. The toolbar may be turned off from the View menu.

The toolbar buttons and their associated actions are:

Icon	Action
	Create a new project
	Open an existing project
	Save your current “whatever.” The toolbar tip text will define the “whatever.”
	Save your current "whatever" in ASCII text format. The toolbar tip text will define the "whatever."

Icon	Action
	Save the APM propagation loss data in Excel format.
	Save the APM propagation loss data in HTML format.
	Print your current "whatever." The toolbar tip text will define the "whatever."
, , and 	Cut, copy, and paste text
	Cancel a window or a process
	Find a file or system name
	Create a new platform
	Create a new radar
	Create a new communications system
	Create a new ESM receiver system
	Create a new target
	Create a new atmospheric environmental file
 and 	Execute the current project or stop a process
	Redisplay the current project
 and 	Pause / Start rotation of decision aids or recording of debugging information
 and 	Rotate decision aid counterclockwise / clockwise
 and 	Step display in / out in range.
 and 	Insert a row into / remove a row from a tabular form

Icon	Action
	Clear the entire contents of a tabular form
	Activate the What's This Help mode
	Obtain full help.
	Show step-by-step help in performing a task

AREPS Popup Menus

Throughout the entire AREPS program, you will find popup menus available by right clicking on an item. For example, if you right click anywhere within a coverage display, it will open a popup menu, figure 4-12, from which you may choose many other options and displays.

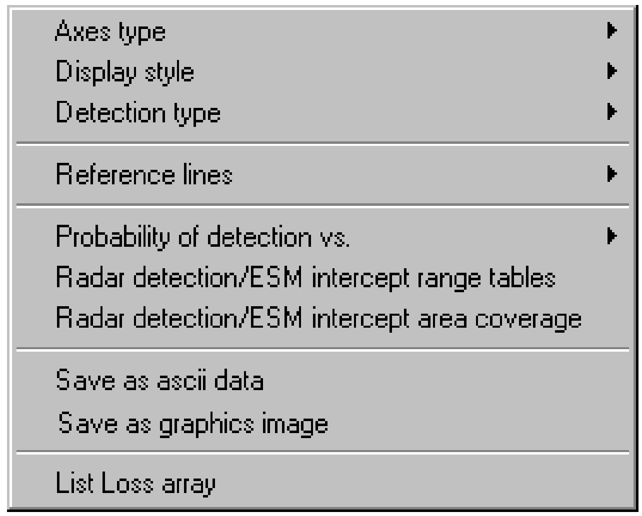


Figure 4-12: Display popup menu.

As another example, if you right click on the atmosphere label found in the project window, you will open a popup menu, figure 4-13, that allows you to change the atmosphere folder or view the current atmosphere data in our general purpose listing window.

A third example is the units changing popup menu, figure 4-14, available by right clicking on any label that contains a unit.

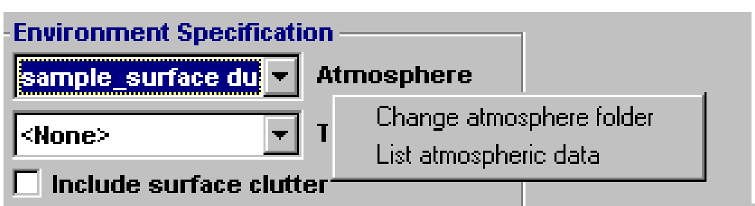


Figure 4-13: Atmosphere popup menu.

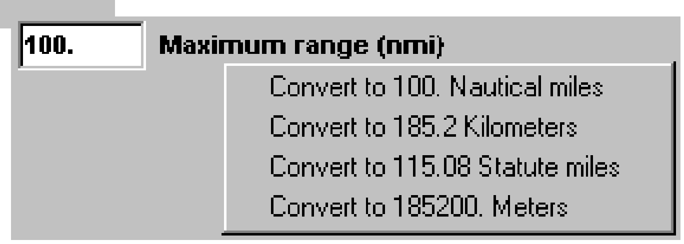


Figure 4-14: Change units popup menu.

PROJECTS AND AUTOMODE

Projects are created/opened from the **File** menu and EM systems are created/opened/removed from the **Systems** menu. When the **New** item is selected from either menu, an appropriate window opens so you may enter the necessary data. If the **Open** item is selected from either menu, an Open/Remove selection window opens.

Open/Remove Window

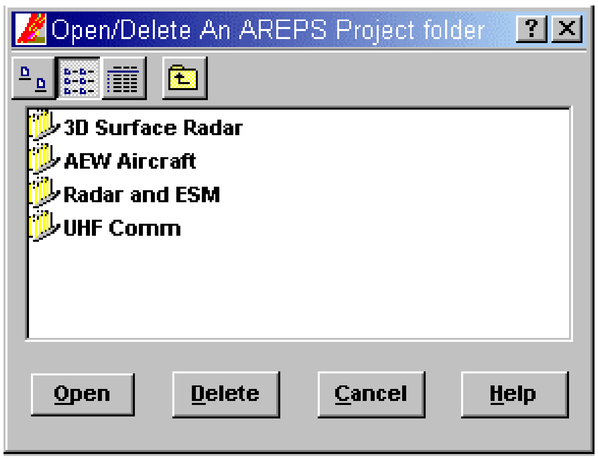


Figure 5-1: Open/Remove window.

When the **Open/Remove** (project, system type, or automode) item is selected from the File or Systems menu, a dialog window, figure 5-1, opens offering you a choice of several command buttons. These are Open, Remove, Cancel, and Help. The title bar of the Open/Remove window will indicate what type of system you are working with.

To open an existing project, system, or automode menu, point to and click on a *name* from the list and then click the **Open** button or just point to and double click on the *name*. To remove a an item, highlight (point to and click on the first name and while holding the mouse button down, drag the mouse to the last name) those you intend to remove, and click the **Remove** button. If more than one name is highlighted, you will receive a confirmation notice. If only one name is highlighted, you will not receive a confirmation notice.

Clicking the **Cancel** button returns you to the main AREPS window where you may select another item from the AREPS menu. Clicking the **Help** button will display information about this window.

In addition to the command buttons, three views of the Open/Remove window are available. You display these views by clicking on one of the three view icons in the Open/Remove toolbar. These views are small icons as shown in figure 5-1,

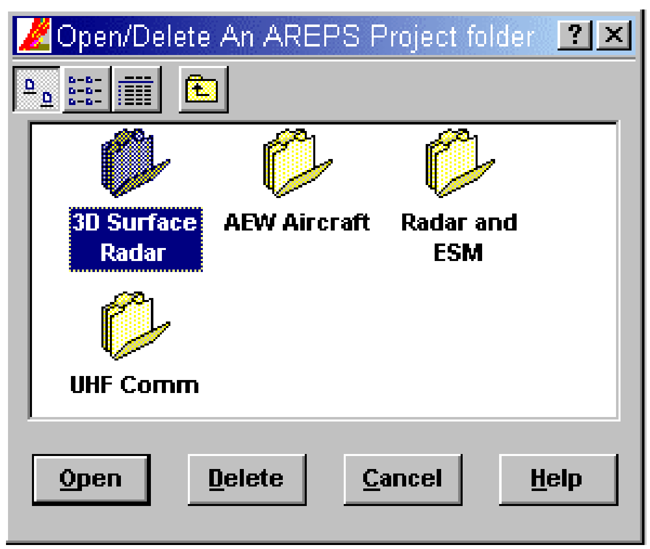


Figure 5-2: Open/Remove window – large icon view.

large icons as shown in figure 5-2, and details as shown in figure 5-3.

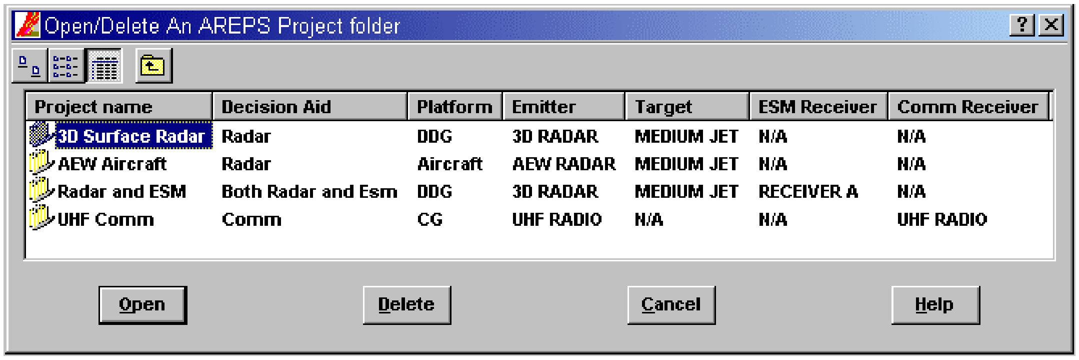
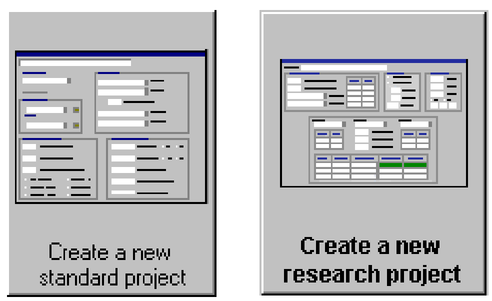


Figure 5-3: Open/Remove window – details view.

In the detail view, a number of system parameters also show in the window. By clicking on the column title bar, the systems may be sorted on that particular parameter. For example, you may sort your system by name, by frequency, or (if a radar system) by identification label. Clicking on the column title a second time will sort the systems in the opposite order. For example, the first click will sort the system names in alphabetical order. The second click will sort the systems names in reverse alphabetical order.

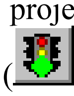
Project Windows

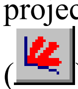


Each run of AREPS is considered a project. A project contains all the display, EM system, and environmental data necessary for AREPS to create your decision aid. All such input data are saved within a subfolder of the project folder.

By selecting the **Standard project** sub-item from the File menu's **New** sub-item, a standard project window opens. If you select **Research project**, the research project window opens. You may optionally open a new project window by clicking on either of the quick-start command buttons.

If you have previously created a project, you may open it by clicking the toolbar Open Project () button or selecting Open/Remove Project from the File menu. When the project selection windows opens, select one by name from the list and click the **Open** button or just double click on the name. To remove a project or projects, highlight those you intend to remove and click the **Remove** button. If more than one project is highlighted, you will receive a confirmation notice. If only one project is highlighted, you will not receive a confirmation notice. Refer to navigating the AREPS windows for a general discussion of data input, editing, etc.

To define and execute a project, provide all the necessary input data and then click the Execute toolbar button () or choose the Execute item from the Run menu. The project will be checked for data input errors. If errors are discovered, you will receive a notice and be returned to the project window. If the project is new, you will be asked for a project name. You may use any name you would like but are limited to 256 characters and you may not use spaces.

If you use a space, AREPS will replace it with an underscore (_) character. If the project has previously been executed, you may click the toolbar **Redisplay** toolbar button () or choose the **Redisplay** item from the **Run** menu to view the project.

The standard project window, figure 5-4, also illustrates two popup menus, one obtained by clicking on the Terrain label and one obtained by right clicking on the Maximum range label. From these popup menus you can change the folder associated with your terrain files, and you can change the units for Maximum range.

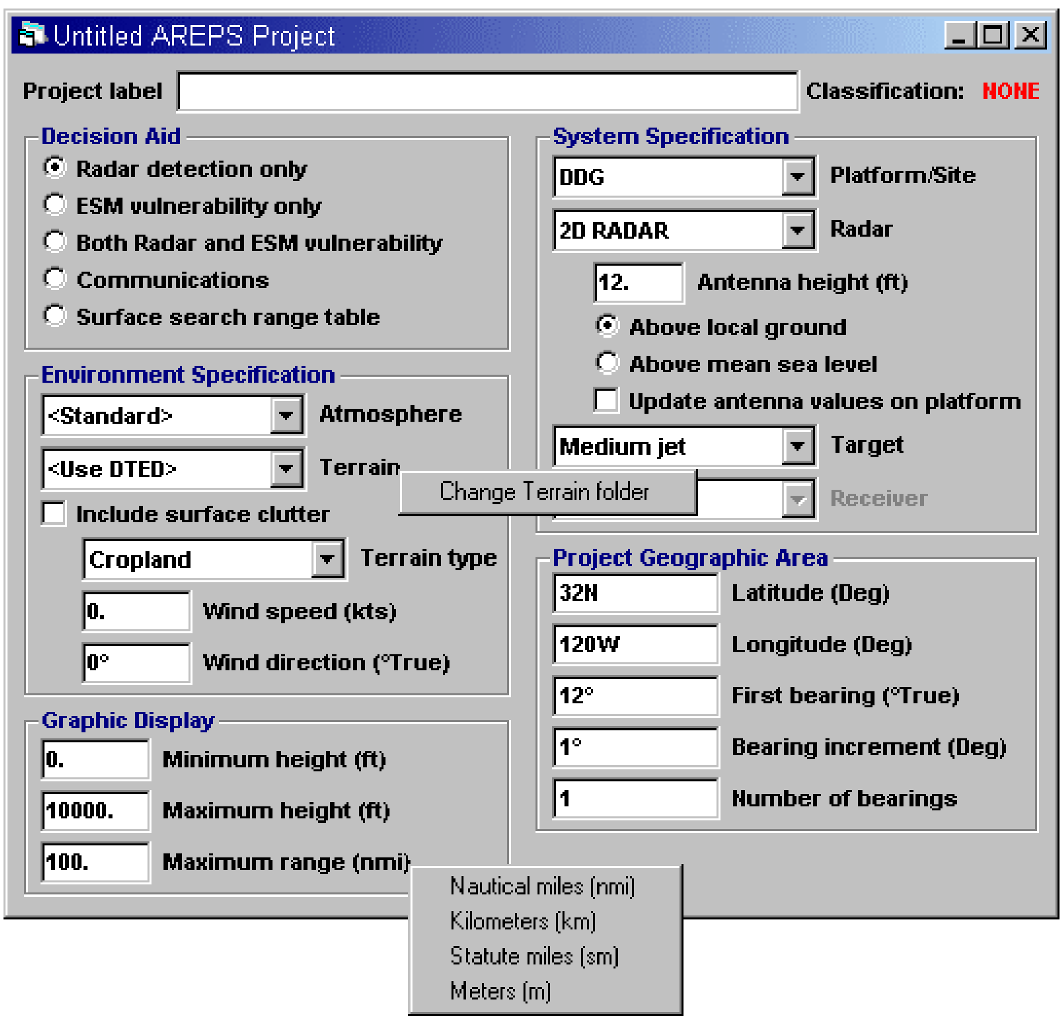


Figure 5-4: Standard project window.

When you enter data into a text field such as maximum range, an error checking convention is used. AREPS assigns limits to most input items. The limits are divided into two groups, a hard limit group and a soft limit group. Hard limits are limits you may not exceed and AREPS will not accept. Soft limits are those we consider to be out of the normal usage range but we will still allow you to enter. If you exceed a hard limit, the background color of the input value will turn to red. If you exceed a soft limit, the background color of the input value will turn yellow. While you may move about a window with a limit violation, you will not be allowed to save a system or execute a project with a hard limit violation.

The research project window, figure 5-5, is designed for those uses that want to exercise APM without having to specify items that are not needed by APM. For example, there is no need to specify a platform, target, or even an emitter from the database. Because the complete set of parameters needed for probability-of-detection or signal-to-noise ratio calculations are not entered, the display type is limited to propagation loss or propagation factor.

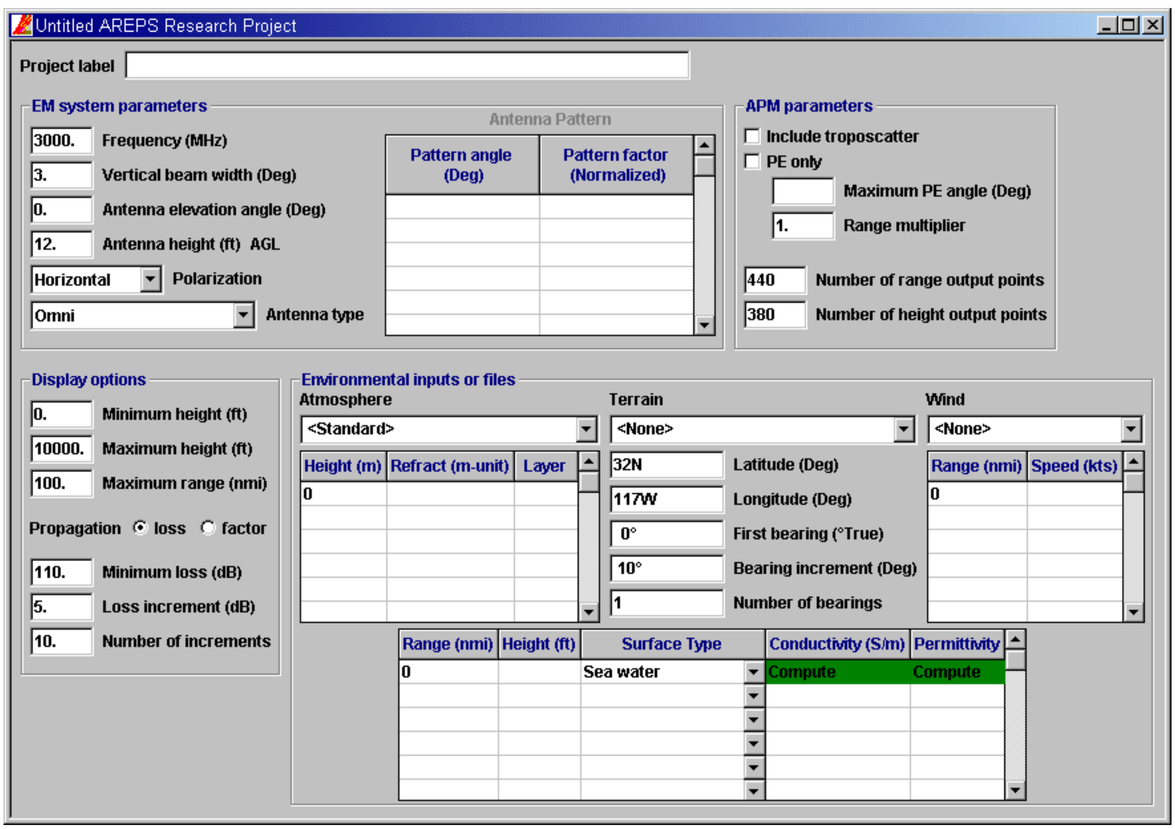


Figure 5-5: Research project window.

You may read your atmosphere specification from a file or you may enter it into the atmosphere's tabular form. You may also do the same for terrain and for surface winds. For the atmosphere specification, a file may contain bearing dependent data. For the terrain and winds, a file may not contain bearing dependent data.

By entering the APM parameters, you may achieve results that are not available via the standard project. For example, for a standard project the limits of elevation angle are –10° to +10°. If you select the PE only option and specify the maximum PE angle, the limits for the elevation angle become –30° to + 30°.

A brief description of each input field or option item follows.

Project Label

The project label is any text you may wish to use to describe your project. This text is displayed at the top of each decision aid. You are limited to 72 characters.

Classification

AREPS allows you to label your data with four different classification labels. For example, label 1 may be "My eyes only." Label 0 is predefined as "None." Label definitions are made from the **Security Labels** item on the **Options** menu. It is your sole responsibility to adhere to the data security requirements dictated by higher authorities. This utility is strictly a labeling convenience feature and, as such, the AREPS developers assume no responsibility for unauthorized release of classified data or misuse of this feature. The project's classification is automatically determined from the highest classification of any of its system components (i.e., radar, platform, ESM receiver, etc.). The classification of your project will show on the decision aid display.

Decision Aids

Select a desired decision aid by clicking on its option button, figure 5-6. The **Radar detection only** option shows radar detection probabilities. From the resulting decision aid graphic, you have the option to change the view to propagation loss, propagation factor, or signal-to-noise. Refer to chapter 10, decision aids, for a further discussion of your display options.

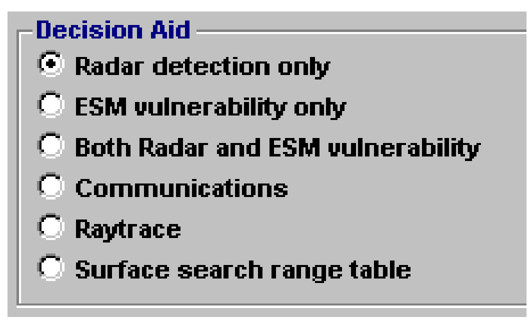


Figure 5-6: Decision aid menu.

The **ESM vulnerability only** decision aid shows vulnerability and no vulnerability in two regions as two colors. The **Radar and ESM** option shows the probabilities of detection and ESM vulnerability simultaneously. The **Communications** decision aid shows regions of communication and no communication. The **Raytrace** decision aid shows a raytrace diagram based upon Snell's law. The raytrace does not use the APM model. The raytrace display is not implemented in the initial release of AREPS 3.0. The **Surface search ranges** decision aid shows a table of detection ranges for various surface-ship targets using your shipborne surface-search radar. If you select this decision aid, certain project inputs will become unavailable (i.e., minimum and maximum height, earth-surface depiction, etc.)

The surface search range table is a part of the AREPS extended capabilities and is only available to registered users of AREPS.

System Specification

The system specification is a grouping of dropdown menus and text input fields that define the project's EM system database requirements. These dropdown menus are populated from the database by clicking on the arrow to the right of the dropdown menu.

Platform/Site Name

A platform or a site is a container for an emitter such as a radar or a radio. A platform is generally thought of as a container that moves, such as a ship, aircraft, or tank. A site is generally thought of as a container that is either fixed or semi-fixed in location such as a communications bunker or a surface-to-air missile emplacement. The platforms are initialized from the **Systems** menu. The collection of emitters on the platform is called the platform's suite. When a platform is selected from the dropdown menu, the emitter names within the suite are copied into the Radar/Communications dropdown menu for your selection. For additional information about the link between the platform's emitter suite and the Radar/Communications dropdown menu, see the **Program Flow** item on **Options** menu.

Radar Name or Transmitter Name

Depending upon how you have specified your platform and emitter dropdown menu link, this dropdown menu contains the emitters (either a radar if you have selected a radar decision aid, or a communication system if you have selected a communications display type). To choose one, simply click on its name.

Antenna Height

The height of the radar or radio antenna above a reference level. The reference level may be the local ground level or mean sea level. For example, a land based system mounted on a truck may reference it's antenna height to local ground level, an ocean based system mounted on a ship may reference it's antenna height to mean sea-level, and an airborne system may reference it's antenna height to either. The height may be in either feet or meters.

Antenna heights are normally entered along with the radar or communication system in the platform window. When you select a platform for your project, the antenna information for your select radar (or communications system) will automatically fill this input field and set the appropriate height reference option button. You may override the height associated with a platform however, by clicking on the antenna height input field and entering a new height. You may also change the reference level by clicking the appropriate option button. If you override the antenna height from the project window, you may check the Update platform checkbox and when the project is saved, its antenna height will replace the one on your selected platform.

Right mouse click on the antenna height label to change units.

The antenna height will be added to any terrain elevation at the starting range. However, the terrain elevation may not be known until the terrain file or DTED CD-ROM is read. If the combination of heights exceeds the maximum display height, the maximum display height will automatically be increased by 1%. You will not receive an error notice

Target Selection

This dropdown menu contains the names of the targets in your database. To choose one, simply click its name. The target and the frequency and polarization of the radar you select for your project will determine the radar cross. The target name dropdown box is gray and unavailable for the ESM vulnerability only and Communications decision aid displays. The target name is shown on the decision aid.

Receiver Selection (Communications or ESM)

This dropdown menu contains the names of the ESM receivers or the communications systems (depending upon the decision aid you have chosen) in your database.

For communication systems, the receiver name may also be the same as the transmitter name, assuming you have a transceiver system.

For ESM receivers, the radar/ ESM receiver parameters will determine the receiver sensitivity used for the project. If the radar and ESM receiver do not have the same polarization, the sensitivity will be reduced by 3 dB for horizontal or vertical polarization radar and circular polarization receiver, or by 15 dB for horizontal polarization radar and vertical polarization receiver (or vice versa).

The ESM or communications receiver name is shown on the coverage diagram.

Environment Specification

Atmosphere Selection

The atmospheric environment files created by the Environment program are ASCII text files and are saved in the Enviro folder. When an atmosphere file is created within AREPS, the file name is appended with an extension of env_.txt. When you click on the Atmosphere dropdown menu, figure 5-7, all the files within the Enviro folder with the env_.txt extension are placed into this dropdown menu so you may select one. The atmosphere file name is also shown on the coverage decision aid.

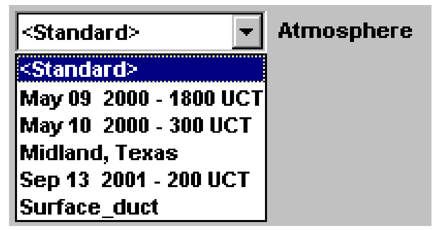
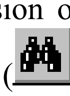


Figure 5-7: Atmosphere menu.

The first item in the dropdown menu is <Standard>. The brackets (< and >) indicate this particular atmosphere is not from a file but defined within the AREPS source code itself. We provide this as a convenience so you don't have to have to maintain certain sample atmosphere files. For the research project, an additional "hard-wired" entry is <Use data from tabular form below>. By selecting this entry, you may enter your atmospheric data into the tabular form rather than having it read from a file. When using the tabular form, the atmosphere may not be range or bearing dependent.

Since you may create your own atmosphere files external to AREPS, they may not have an env_.txt extension and their locations may not be in the Enviro folder. If the environment file you desire does not have the env_.txt extension or is not within the Enviro folder, you may click the toolbar **Find file** toolbar button () or select the **Find file** item from the **Edit** menu to browse to its location. Once selected, its name is added to the dropdown menu. The Find feature will become active when the atmosphere dropdown menu gains your focus.

Even though you use the default environment folder, you may have your own atmosphere files in a different folder. To temporally change the environment folder, click (right or left) the Atmosphere label to open a folder browse window and then browse to your desired folder. The dropdown menu will be repopulated with the files in your new folder.

 To insure your externally created environment files display in the environment dropdown menu, you must give them an env_.txt extension and save them within the Enviro folder

Terrain Selection

The terrain selection dropdown menu, figure 5-8, contains the names of any terrain files you may have created yourself together with two other entries. To select a terrain, simple click on the one you want.

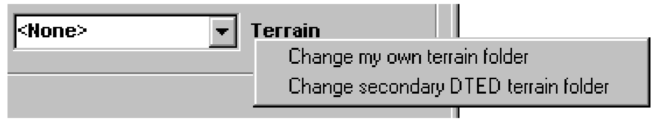
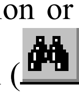
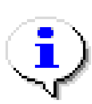


Figure 5-8: Terrain menu.

The first item in the dropdown menu is <None> and the second is <Use DTED>. The brackets (< and >) indicate these particular items are not files but are defined within the AREPS source code itself. We provide these two options as convenient defaults. For the research project, a third "hard-wired" entry in the dropdown menu is <Use data from tabular form below>. By choosing this entry, you may specify your terrain by entering it into the tabular form. Refer to chapter 9, Terrain, for a complete discussion of using the tabular form. Following these "hard-wired" entries, is a listing of all terrain files saved in the terrain folder.

When a terrain file is created within AREPS, the file name is appended with an extension of ter_.txt. The terrain file name is also shown on the coverage decision aid. Since you may create your own terrain files external to AREPS, they may not have a ter_.txt extension and their locations may not be in the Terrain folder. If the terrain file you desire does not have the ter_.txt extension or is not within the Terrain folder, you may click the toolbar **Find file** toolbar button () or select the **Find file** item from the **Edit** menu to browse to its location. Once selected, its name is added to the dropdown menu. The Find feature will become active when the terrain dropdown menu gains your focus.

Even though you use the default terrain folder, you may have your own terrain files in a different folder. To temporally change the terrain folder, click (right or left) the Terrain label to open a folder browse window and then browse to your desired folder. The dropdown menu will be repopulated with the files in your new folder. For the FalconView overlay, you have a second option to change your DTED secondary folder. This allows you to browse for DTED data that may be segmented by geographical areas. This folder change is only temporary for your current FalconView session. When the FalconView overlay window closes, your secondary DTED folder will be reset back to your initial specification.

 To insure your externally created terrain files display in the terrain dropdown menu, you must give them an ter_.txt extension and save them within the Terrain folder

Surface Clutter

Surface wind speed is used in the calculation of a rough ocean surface. A rough ocean surface will scatter the energy and hence, create a greater propagation loss. AREPS is capable of calculating surface clutter from a rough ocean (and terrain) surface. This clutter calculation is independent of the rough ocean calculations. You may include both effects by checking the **Include surface clutter** checkbox and entering a wind speed, a wind direction, and selecting a terrain surface type from the dropdown menu, figure 5-9. If you only enter a wind speed and leave the Include surface clutter checkbox unchecked, AREPS will include only the ocean scattering effects.

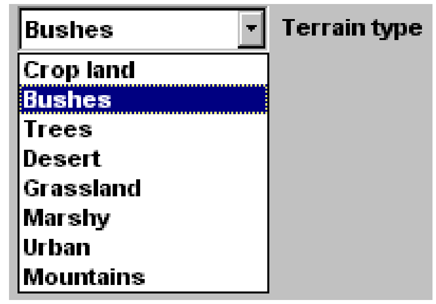


Figure 5-9: Surface terrain type.

Currently, AREPS standard project does not allow for a range-dependent surface wind. Thus, you may enter only a single speed and direction. Range-dependent surface winds are a future option.

Wind Selection (Research Project)

The wind selection dropdown menu, figure 5-10, contains the names of any wind files you may have created yourself together with two other entries. To select a wind, simple click on the one you want.

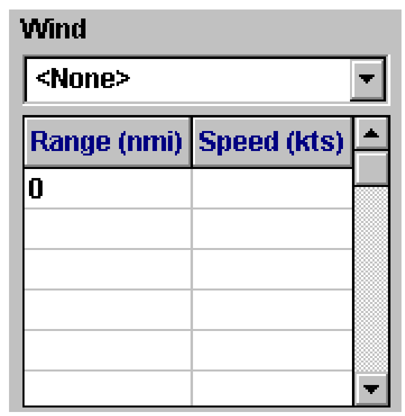
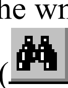


Figure 5-10: Wind menu.

The first item in the dropdown menu is <None> and the second is <Use data from tabular form below>. The brackets (< and >) indicate these particular items are not files but are defined within the AREPS source code itself. We provide these two options as convenient defaults. By choosing the tabular form entry, you may specify your wind by entering it into the tabular form.

Following these "hard-wired" entries, is a listing of all wind files saved in the wind folder. The wind files must be of the proper format. At the present time, the only way for AREPS to create a wind file is to enter the data into the tabular form and then click the wind label for a popup menu. One of the menu items is to save the wind in an ASCII text file. When a wind file is created within AREPS, the file name is appended with an extension of wnd_.txt.

Since you may create your own wind files external to AREPS, they may not have a wnd_.txt extension and their locations may not be in the wind folder. If the wind file you desire does not have the wnd_.txt extension or is not within the wind folder, you may click the toolbar Find file () button or select the Find file item from the Edit menu to browse to its location. Once selected, its name is added to the dropdown menu. The Find feature will become active when the wind dropdown menu gains your focus.

Even though you use the default wind folder, you may have your own wind files in a different folder. To temporarily change the wind folder, click (right or left) the Wind label to open a folder browse window and then browse to your desired folder. The dropdown menu will be repopulated with the files in your new folder.

To ensure your externally created wind files display in the wind dropdown menu, you must give them an wnd_.txt extension and save them within the Wind folder.

Wind File Format

When entering winds into a research project, you may read it from an ASCII text file. The format of the file is the same as that used by Microsoft in their initialization files. There are sections identified by name inside square brackets [] and within each section, there is a variable name, an equals sign, a data value, and optionally, a comment proceeded by the # sign. Below is a sample of a wind file. It is not necessary to include the section header [Wind center] and any of the information under the section header. By default, wind ranges are assumed to be in kilometers, speeds are in meters per second, and directions are degree True.

```
[AREPS Wind]          # Areps30  September 18 2002 14:33:35
[Wind center]
Latitude   = "  0°N" # Center latitude
Longitude  = "  0°E" # Center longitude
Bearing    = "  0°T" # Bearing from center
RangeUnits = "nmi"   # Range units for wind points
SpeedUnits = "kts"   # Speed units for wind points

# 5 Wind points : Range(nmi) Speed(kts) Direction(T)
[Wind]
Wind       = 0 10 0
Wind       = 20 5 0
Wind       = 30 15 0
Wind       = 40 25 0
Wind       = 50 18 0
```

Graphic Display Grouping

Minimum Height

The minimum height for the decision aid. For shipboard systems, this should be set to 0 (mean sea level). For land based systems, a different minimum may be used. The lowest elevation on earth is the Dead Sea at -1,302 feet below sea level. For this geographical area, the minimum height would be set to -1,302 feet. The units may be feet or meters and may be changed by right mouse clicking on the minimum height label. Units of minimum and maximum display height may not be mixed.

You must have your environment specified from this minimum height to the maximum display height. If the first height specification is above this minimum height, a decision needs to be made about how to proceed. You may have AREPS extrapolate the environment downward from the first specified height to the minimum height using either a standard atmospheric gradient or using the gradient between the first and second height levels in the specification. You may make this decision before the project starts by selecting which method you would like from the Program Flow item on the Options menu.

Maximum Height

The maximum height for the decision aid. The units may be feet or meters. Right click the maximum height label to change units. Units of minimum and maximum display height may not be mixed.

The maximum height should be above the highest elevation of any terrain within the scope of the project. Since the terrain elevation may not known until the project starts executing, if your maximum height is below the terrain elevation, the maximum height will automatically be increased by 1% over the terrain. You will not receive an error notice.

You should have the environment fully specified to the maximum display height. If it is not, a decision needs to be made about how to proceed. You may have the decision aid stop at the height of the environment specification or you may have the profile extrapolated to the maximum display height using one of several techniques. You may make this decision before the project starts by selecting which method you would like from the Program flow item on the Options menu

Maximum Range

The maximum range for the decision aid. For range dependent environments, you should have the environment fully specified to the display range. If it is not, a decision needs to be made about how to proceed. You may have the decision aid stop at the range of the last environment specification or you may have the last specification extrapolated to the display range. In the case of the latter, your environment will be horizontally homogeneous (not range dependent) from the range of the last specified profile to the display range. You may make this decision before the project starts by selecting which method you would like from the Program flow item on the Options menu.

The units may be kilometers, nautical miles, or statute miles and may be changed by right mouse clicking on the maximum display range label. Attention should be paid to the input limits shown in the prompt panel, as maximum ranges are different between units.

Project Geographic Area Grouping

Latitude and Longitude

The latitude and longitude is used to extract terrain data from the DTED CD-ROMs.

The value may be entered in degrees, minutes, and seconds. The format may be decimal numbers or integer numbers separated by a space. For example, if you enter 36.5 and then press the Enter key or leave the input box, the field will change to 36°30'. You may also enter a decimal value for both the minutes and the seconds. For example, if you enter 32.5 degrees 16.3 minutes, and 17.5 seconds, the field will change to 32°46'36".

When entering latitude and longitude values, you must also specify a quadrant. This may be W for west, E for east, N for north, or S for south. When both lower and upper bounds of an input field are in the same quadrant, AREPS will automatically select the quadrant and enter it for you so you don't have to type it yourself. If the bounds are in different quadrants, you must enter it. If you don't, the default is east longitude and north latitude. For those uses exclusively in the southern or western hemispheres, the default can be an annoyance. Thus, you can choose to have the default hemispheres other than Northeast. Once set from the Program flow item on the Options menu, you no longer need to type the quadrant into the field.

The latitude and longitude specified will remain until you change it, select a stationary platform, or enter your own terrain file containing a latitude and longitude. If you should happen to select a mobile platform after a stationary site, or choose DTED terrain after your own terrain file, the latitude and longitude will remain unchanged. Please insure the project latitude and longitude are what you want them to be before proceeding. If you leave the latitude and longitude fields blank, AREPS will not consider terrain unless you have specifically selected DTED for your terrain type. In this case, you will receive an error message asking for a latitude and longitude.

If you do not specify a latitude and longitude, the latitude and longitude for the area coverage display will be set to zero so you may still see the range and bearing information when using the mouse cursor.

First Bearing

AREPS can display decision aids in a 360-degree azimuth scan. The first true bearing is that bearing for the first decision aid. The bearing may be from 0 to 360 degrees (0 and 360 are assumed to be the same bearing).

The value may be entered in degrees, minutes, and/or seconds. The format may be decimal numbers or integer numbers separated by a space. For example, if you enter 36.5 and then press the Enter key or leave the input box, the field will change to 36°30’. You may also enter a decimal value for degrees, minutes, and seconds. For example, if you enter 32.5 degrees 16.3 minutes, and 17.5 seconds, the field will change to 32°46’36".

Bearing Increment

The number of degrees, minutes, and/or seconds between the first bearing and the next successive bearing for an azimuth display.

The value may be entered in degrees, minutes, and seconds. The format may be decimal numbers or integer numbers separated by a space. For example, if you enter 36.5 and then press the Enter key or leave the input box, the field will change to 36°30’. You may also enter a decimal value for the degrees, minutes, and seconds. For example, if you enter 32.5 degrees 16.3 minutes, and 17.5 seconds, the field will change to 32°46’36".

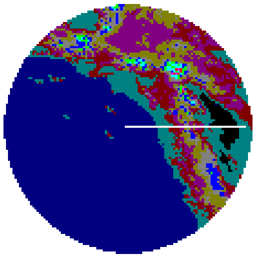
Number of Bearings

The total number of bearings desired for an azimuth display. For example, 360-degree coverage will be generated if the number of bearing is 36 and the bearing increment is 10 degrees. The minimum number of bearings is 1. Care should be used in selecting the number of bearings to prevent generating more than 360 degrees of coverage. Exceeding 360 degrees of coverage will only reproduce previously generated decision aids and cause longer program execution times.

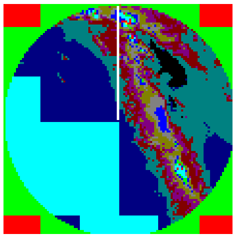
To use a range and bearing dependent atmosphere, you should have the atmosphere fully specified at each project bearing. For AREPS 3.0, if an environment is not specified along a project bearing, the closest bearing will be used. In addition, the latitude and longitude of the atmosphere’s center will be checked against the latitude and longitude of the project. If the center is more than 50 kilometers away, you will receive an error message and the project will not execute. You must insure your project and your range and bearing dependent environment coincide.

AREPS allows you to specify you own terrain along a single bearing. If you have requested more than one bearing and are also using your own terrain, you will receive a warning notice, the number of bearings will be automatically set to one, and the project will continue.

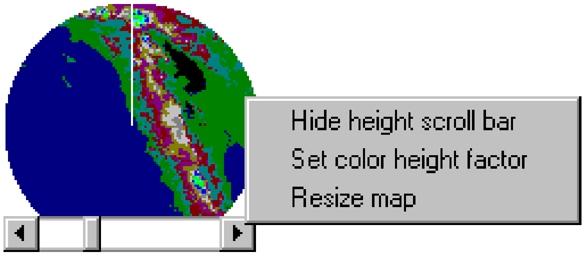
Terrain Map



If you have chosen to use DTED data with your project, a DTED map display appears in the lower right corner of the decision aid. The map shows the 360-degree terrain height coverage centered on the project's latitude and longitude with a radius of the project's maximum display range. Superimposed on the map is a white bearing line showing the current bearing of the display. By moving the mouse pointer over this map, height and other information is shown on the right side of the decision aid. For the initial release of AREPS 3.0, only the 360-degree (circular) map is available. Future versions of AREPS will provide other features for this map.



If AREPS is running in its Debug mode or if certain DTED files are missing, the terrain map may have a different look. The colors indicate different file conditions. As you move the mouse cursor over the map, these conditions are shown in the right panel of the status bar. Using the picture to left as an example, the red squares indicate missing DTED files. The green squares represent DTED files within the square latitude/longitude boundary of the project's maximum range but outside of the bearing sweep range, and the cyan color represents DTED files that contain no data, that is, assumed to be water.



The DTED map has a number of options that may be set from a right-click popup menu. By using the scroll bar, you may change the height increment associated with each color. You may also specify the height increment exactly. By default, the map radius is 56 screen pixels. You may change the size of the map by entering a different pixel radius. These options may also be set from the Active Project item of the Options menu.

Earth Surface Depiction

Radar, ESM, and communications decision aids may be displayed upon one of three different earth presentations, either a **flat**, **curved**, or **dual curved** earth as illustrated in figure 5-11.

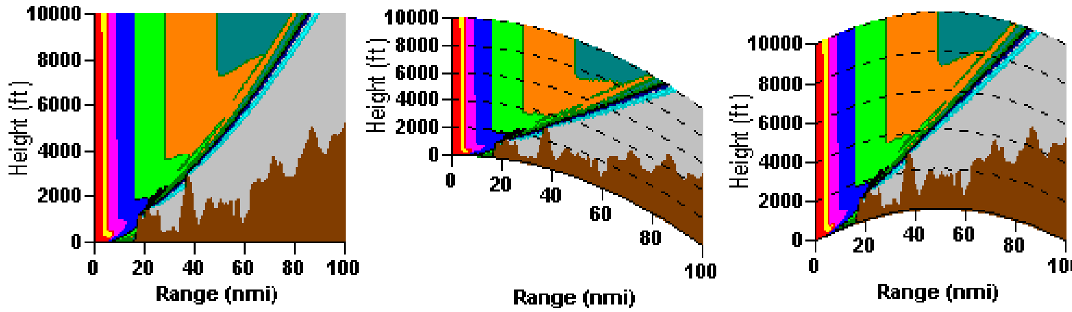


Figure 5-11: Earth surface depictions.

By default, the initial surface depiction is flat. You may change the depiction by selecting the depiction type from a right-click popup menu of the coverage display. You may change the default from the **Project Display** item of the **Options** menu.

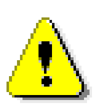
Use caution when selecting graphic height and range combinations with the curved earth depiction, as improperly selected values may make the display hard to interpret or misleading upon casual inspection.

APM Parameters

Tropospheric Scatter

Until the late 1940s it was assumed that diffraction was the only standard propagation mechanism that could contribute energy beyond the line of sight. However, theory and numerous radio experiments have shown that energy scattered from refractive index inhomogeneities just inside the optical interference region will dominate the diffraction field a sufficiently large ranges. This mechanism is called tropospheric scatter or troposcatter. At ranges far beyond the horizon, the propagation loss is dominated by troposcatter. If you want to include troposcatter in your research project's calculations, click the check box.

PE only

 If you are using the PE only calculation option, you must do so with caution as you must have some knowledge of PE algorithms and how they work to input proper combinations of maximum calculation angles and range steps for a given frequency.

When using this option, most error checking is bypassed and parameter limits can be over-ridden. If you choose this option, the parameters of maximum PE angle and range multiplier must be specified.

THMAX is the maximum propagation angle the PE algorithm will accommodate in the field calculations without distortion (i.e., largest angle within the unfiltered spectral domain). *RMULT* is a range step multiplier, allowing the user to vary the PE range step from the default calculated. The vertical height spacing, or mesh size *dz*, used for PE calculations is dependent on *THMAX*:

$$dz = \frac{\lambda}{2\sin\theta} \quad ; \; \theta = \frac{4}{3} THMAX$$

where λ is the wavelength. Due to the use of the FFT algorithm, *THMAX* is increased by a fraction to allow for appropriate windowing/filtering of the complex field.

The corresponding range step used within the PE algorithm, *dr*, is automatically computed with the variable *RMULT* defaulted to 1. However, since *THMAX* can be appreciably varied, the automatically determined range step may not be optimum for the particular value of *THMAX*. Specifying a positive real value for RMULT allows you to increase or decrease the internally calculated range step:

$$dr = RMULT \; dz$$

Erroneous field values may result if a poorly chosen combination of maximum PE angle and range multiplier is used.

Number of range output points

In order to produce a nice looking coverage display, the standard project defaults the number of points in range that APM produces to 440. This number was chosen because the design of the coverage display is 440 pixels wide. However, there may be times that you want an APM value at a particular range or ranges that don't happen to correspond to one or several of these 440 points. For the research project, you may enter the number of range points you want. For example, if your maximum range is 100 kilometers and you specify 100 points, you will receive an APM value at each kilometer.

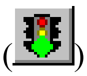
Please understand that if you specify less than 440 points, the coverage display will degrade in appearance. However, the purpose of this input is to allow you to get APM values at the specific ranges you want and not necessarily to produce pretty pictures.

Number of height output points

In order to produce a nice looking coverage display, the standard project defaults the number of points in height that APM produces to 380. This number was chosen because the design of the coverage display is 380 pixels high. However, there may be times that you want an APM value at a particular height or heights that don't happen to correspond to one or several of these 380 points. For the research project, you may enter the number of height points you want. For example, if your maximum height is 500 meters and you specify 500 points, you will receive an APM value at each meter.

Please understand that if you specify less than 380 points, the coverage display will degrade in appearance. However, the purpose of this input is to allow you to get APM values at the specific heights you want and not necessarily to produce pretty pictures.

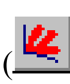
Execute Project

Click the E**xecute** toolbar button () or choose **Execute** item from the **Run** menu to start the decision aid calculations. The project will be error checked and if error-free, saved. If an error occurs, you will be returned to the error point and asked to correct the problem before you may continue. If it is a new project, you are asked for a project name. You may use any valid Windows 95/98/NT/2000-folder name up to 256 characters including spaces. However, AREPS will automatically replace all spaces with the underscore (_) character. While not allowing spaces in a folder name is a DII-COE requirement, AREPS will also use this convention for non-DII COE users.

If you are using DTED terrain, the required DTED CD-ROMs will be requested, the terrain map will be created, and the terrain will be drawn. AREPS allows you to specify you own terrain along a single bearing. If you have requested more than one bearing and are also using your own terrain, you will receive a warning notice, the number of bearings will be automatically set to one, and the project will continue.

After the terrain is drawn, the propagation model will generate the decision aid for each bearing desired. Once all decision aids are completed, they will be displayed in sequence. Using toolbar buttons, you may pause the program anywhere in this process to take advantage of many additional features.

Redisplay Project

Click the **Redisplay** toolbar button () or choose **Redisplay** item from the **Run** menu to redisplay previously computed projects. If any project data have changed from a previous run, the project will automatically re-execute where needed to insure current information.

Project Initialization File

Before the project is executed and after the project is error checked, a project initialization file will be created and saved in the project's subfolder of the AREPS projects folder. The file's name will be the same as the project with an .ini extension. This file is an ASCII text file that may be opened a viewed with any text editor. We recommend you do not change any values within the file, external to AREPS.

The initialization file contains every single piece of data needed to fully recreate the project (with the exception of the DTED terrain data). If you should receive an error during the calculations, you may email the file to technical support so we can reconstruct and resolve the error.

The format of the file is the same as that used by Microsoft in their initialization files. There are sections identified by name inside square brackets [] and within each section, there is a variable name, an equals sign, a data value, and optionally, a comment proceeded by the # sign. Refer to the AREPS on-line help file for a complete discussion of the initialization file format.

Automode Window

The automode is an automatic product generation feature designed for an operator who needs to produce a number of products on a routine basis where the only things to change within a project is the environment and possibly the platform's location. The automode menu editor is opened by selecting Automode menu from the File (new or open/remove) menu or by clicking the Automode quick action command button.

To the left of the window, figure 5-12, is a listing of all your projects. Click on a project's name to select it. You may select multiple projects by holding down the Shift or Ctrl keyboard keys while you click. When all your desired projects are selected, click the **Add →** command button and the projects will be added to your automode menu. Should you want to delete a project from the automode menu, click on its name in the first column of the menu's tabular form and click the **← Remove** command button. To remove all the projects from the menu, you may click the **Clear** toolbar button ().

The menu's tabular form has six columns. The first column shows the project names. You may right-click on the project's name to view all the project's parameters.

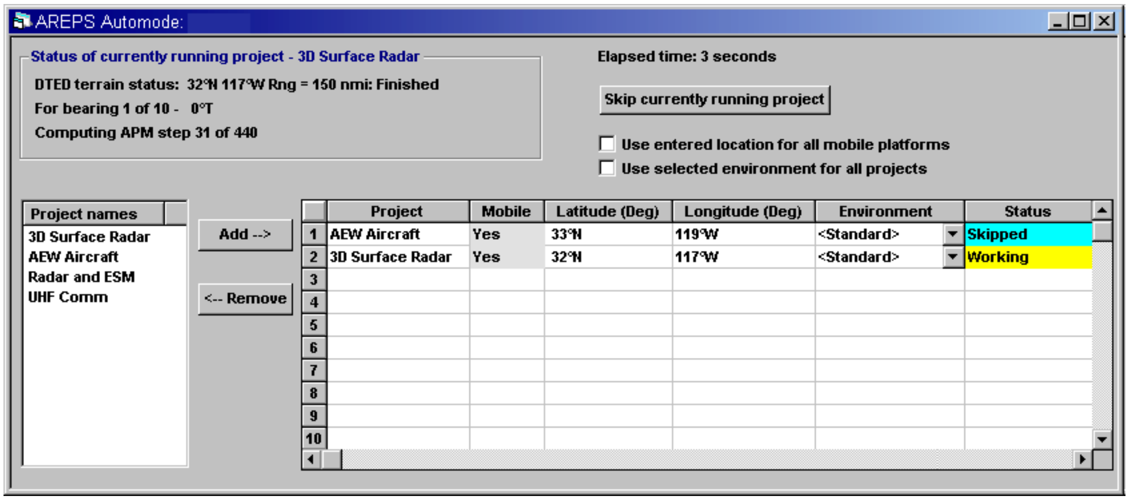
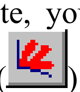


Figure 5-12: Automode menu window.

The second column shows if the platform of the project is mobile or not. The third and fourth columns show the project's center location. If the project has a mobile platform, you may edit the latitude and longitude fields. If the platform is stationary, you may not. By checking the **Use entered location for all mobile platforms** checkbox, any change you make in any project's latitude or longitude will be reflected in all the projects.

The fifth column shows the project's current environment. To change it, select a new environment from the column's dropdown menu. By checking **the Use selected environment for all projects** checkbox, any change you make in any project's environment will be reflected in all the projects.

The sixth column shows the current status of the project within the automode run process. As the automode is running, the status text will change along with the column's background color. Additional status information is shown within the status frame.

Once you are satisfied with your automode menu, click the **Execute** toolbar button () or choose **Execute** from the Run menu to start the automode menu running. If not already saved, you will be asked to save the automode menu. Prior to starting the first project, all the projects' DTED requirements are checked. You will be asked to provide any required DTED data at this time. Once these data are provided, the automode will continue without any further attention. After the automode menu is complete, you may return to the individual projects and click the **Redisplay** toolbar button () to view the results.

While the automode menu is running you may click the **Skip currently running project** command button to stop the current project and start the next one. You may also click the **Stop** toolbar button () or choose **Stop** from the Run menu to completely stop the automode process.

Automode assumes each project and environment is without errors. If an error is encountered during the execution, the offending project will be terminated and the automode will continue with the next project in the menu. You may click on the Status column to open an error window providing additional details of why the project was terminated.

FalconView Overlay

The Naval Portable Flight Planning Software (N-PFPS) package provides the capability for flight mission planning. One component of N-PFPS is FalconView, a mapping package for the PC, which displays various types of maps and geo-referenced overlays. AREPS is able to display its output upon a FalconView background.

In order to use a FalconView overlay, the FalconView program should already be running. If FalconView is not running and you are using Windows 2000, AREPS will start it first and then draw to it. If you are not using Windows 2000, the call to initialize the overlay may cause your system to become unstable producing unpredictable results. We strongly suggest you start the FalconView program before using an overlay.

The FalconView overlay window, figure 5-13, opens by selecting FalconView overlay from the File (new or open/remove) menu or by clicking the FalconView overlay quick action command button. The FalconView overlay window provides the data entry point for displaying AREPS outputs upon a FalconView background. The FalconView overlay is treated as a project type by AREPS and all the project functions such as opening, executing, editing, saving, data entry, etc., apply equally to the overlay window.

Each execution of AREPS creates a multiple-instance overlay that may be saved in a FalconView draw (*.drw) file. This draw file is saved from the File/Save As menu of the FalconView program and not by any controls within AREPS. Draw files may be transmitted to other FalconView users who may then import them into FalconView for display.

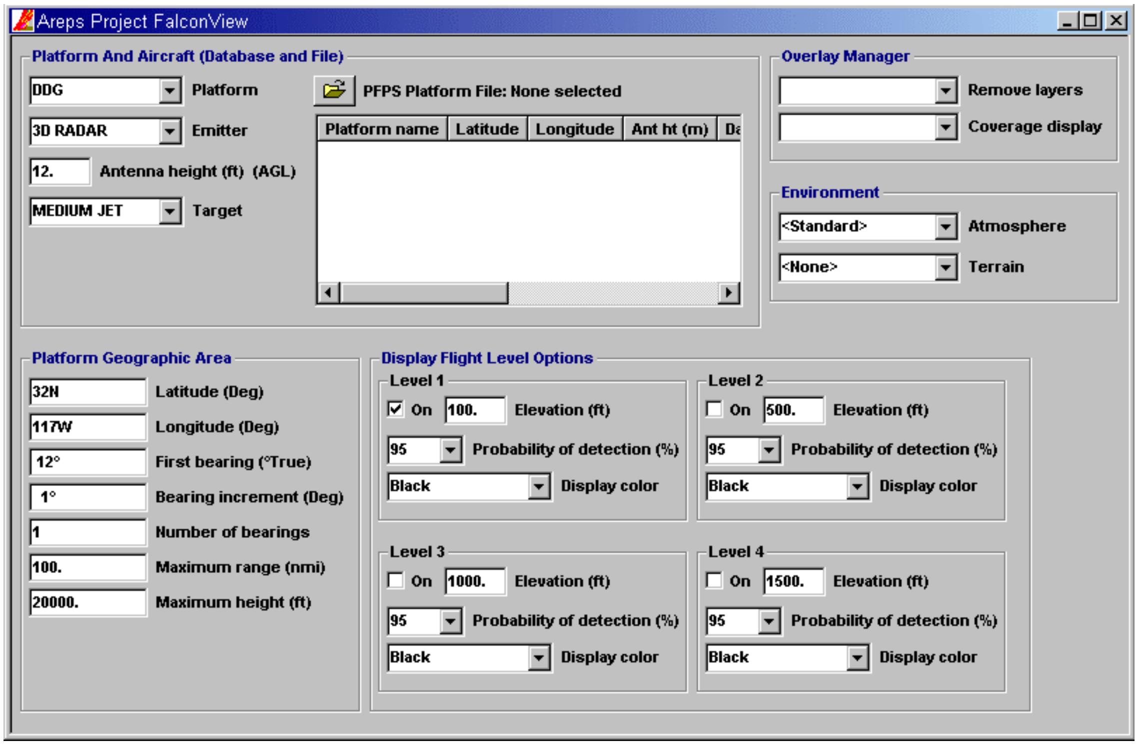
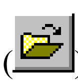


Figure 5-13: FalconView overlay window.

FalconView platform file

One flight planning consideration is a pilot's vulnerability to detection by radar. This of course is one aspect of AREPS' assessment. There are a number of overlay files used by N-PFPS. The one of concern for AREPS is the platform overlay file (*.thr). The platform overlay file contains information for both the Platform itself (its name, its location, and time), and the associated radar (its name, its antenna height, and other information).

You may select and open a platform file by clicking on the file open icon (). By default, the search folder is that specified by you when you installed AREPS. However, you may use the Open file window to browse to any folder. To populate a number of the FalconView overlay inputs, simply click on the name of the platform. If the platform is not in the system database, you will receive a notice and the inputs will not be populated.

FalconView multiple-instance overlay

Each execution of AREPS creates a multiple-instance overlay. As an overlay is created, it is added to the Current layers dropdown menu. In addition, it is added to the Coverage dropdown menu.

If you select an overlay from the Layers dropdown menu, it will be erased from the FalconView display. The only way to restore it to the FalconView display is to re-execute the overlay project that created it.

We made a conscious decision not to delete any AREPS files associated with erased overlays. This means that AREPS will be using additional disk space. Thus, if you want to completely remove an overlay, you will need to manually delete these AREPS files. Each overlay is saved in its own sub-folder of the FalconView overlay's main folder. These subfolders are labeled Overlay_X where the X represents the number of the overlay generated. Each overlay's initialization file is named XXX_FVaaaa.Ini where XXX is the name of the main FalconView overlay and the aaaa is the number of the overlay.

Because each multiple-instance overlay is itself a project, all of the project's outputs are saved, including any optional files you may have chosen to save. By selecting an overlay from the Coverage dropdown menu, you may view the height versus range display, the loss versus range/height display, the table and bargraph display, and the normal AREPS area coverage display.

FalconView flight levels

As with the AREPS area coverage display, an AREPS output displayed on a FalconView background applies to a single elevation or flight level. You may specify up to four different flight levels each with its own probability of detection and drawing color. Simply check the flight level box if you want to include it, enter a flight level, select a probability of detection, and select a color. You may change the units of height by right clicking on the flight level label. If your desired probability of detection is not within the dropdown menu, you may type the number into the first row of the dropdown menu.

If you desire, you may right click the probability of detection label and select signal-to-noise ratio from the popup menu. By default, the signal-to-noise ratio threshold is set to 0 dB. This means that any positive signal-to-noise ratio values will be displayed on the FalconView background. You may change the signal-to-noise ratio threshold by selecting one from the dropdown menu.

EM SYSTEMS

Database Utilities

Master EM System Database

For the convenience of our authorized DoD customers, we are maintaining a master database. The master database may be used to populate your current database. You may request a copy of the master database in serialized correspondence upon official command letterhead. Our master database will only be mailed to command security managers and not to individuals. Please contact technical support for additional details. In addition, authorized users may download our master database from our SIPRNET homepage.

We have named our database MasterDatabase.txt. To avoid confusion, we strongly encourage you not to use the name MasterDatabase.txt for any of your master or working databases. In addition, we strongly encourage you not to edit our master database, but use it only to populate your own working databases. AREPS contains no functionality to edit our master database.

Current Database Information

When AREPS starts, its current database is automatically opened and made ready for use. You may think of this database as your working database. By default, the current database name is ArepsDatabase.txt. Starting with AREPS version 3.0, the format of the database is ASCII text vice Microsoft Access. (For your convenience, we provide a format conversion utility program.) .While possible, we STRONGLY recommend against editing the database external to the AREPS program.

While individual database entries may be seen in their entirety from one of the system windows, it may be desirable to view the database in its entirety. By selecting this menu item, a listing window, figure 6-1, will open showing you the contents of the entire database. It also shows the name of the current database and the version of AREPS that created it. You may use the option buttons to view the various components of the database. You can not edit the database from this window. Again, all editing should be done from the individual system windows.

By right clicking on a system name, its entire data may be displayed in a general-purpose list window, figure 6-2. From the list window, the data may be saved in an individual file, printed, or copied to the clipboard.

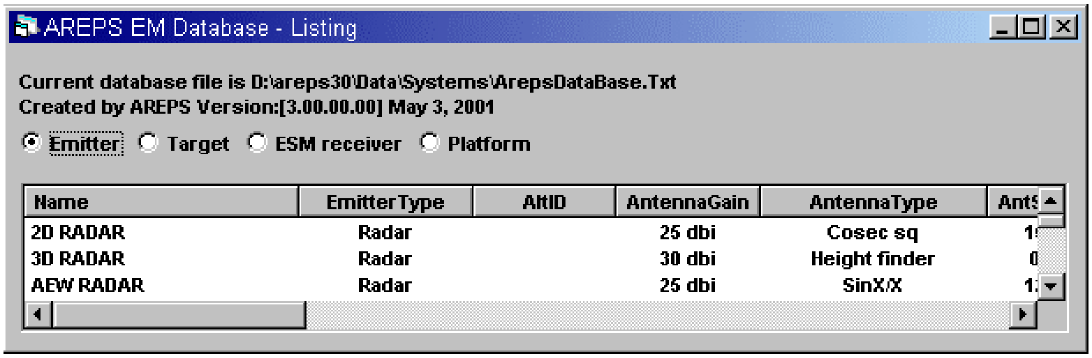


Figure 6-1: Current working database information.

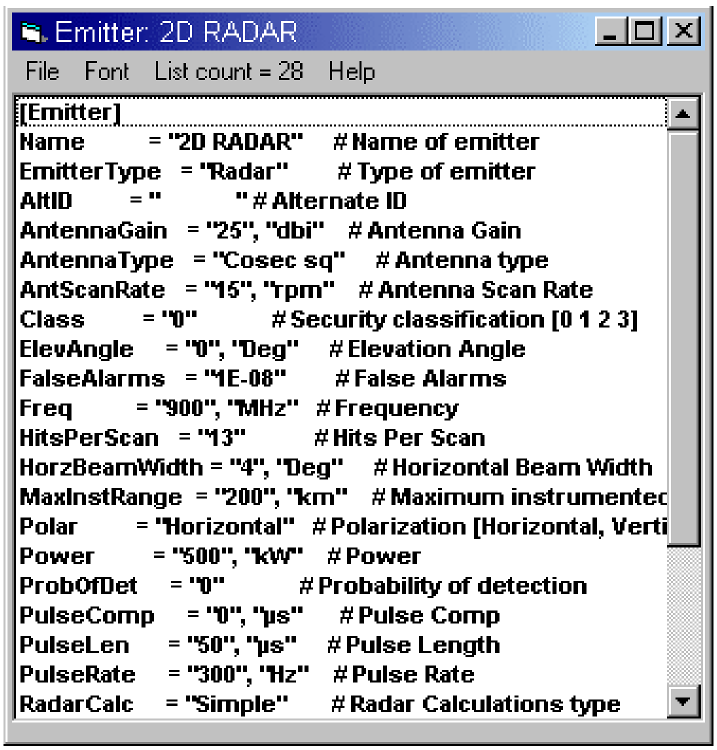


Figure 6-2: General purpose listing window.

Create new (empty) database

This menu item is similar to the Save database as…menu item. The difference is the database you create (save) with this menu item will be empty of platforms and systems.

This option will create the empty database by deleting the entire contents of your current working database. Before doing so, you have the opportunity to save your current database with a different name. We highly recommend you do so.

You may want to create an empty working database in preparation for populating it from your master database. In this way, you can be sure your working database will only contains systems that have your current interest. Another possible use of this menu item is to create databases to distribute to other AREPS users. For example, you may be the METOC division onboard an aircraft carrier and have a very well defined working database. By creating an empty working database and then populating it from your master database, you will have subset working databases, which you may distribute to other non-METOC AREPS users within your command or battlegroup. Please do not confuse your well defined "master" database with the master database we provide.

Open an existing database

When working with large numbers of platforms or systems, it may be desirable to maintain a number of working databases, each containing systems and platforms for a particular purpose. For example, you may have different working databases corresponding to different battlegroups or different country's emitters. You may use this menu item to change your working database.

Save Database As…

Over time, your EM database may grow very large in size and, consequently, the system open windows will grow in complexity. It may be important for you to maintain the most complete database possible. You may use this menu item to save your working database under a different name. You may think of this large database as your master database and possibly save it with the name similar to MyMasterData.txt

On a day-to-day basis, however, it may not be desirable to have this large database as your working database. You may save your master database with a different name and then open this newly named database and delete the systems you are not interested in. For example, this technique may be used to create subset-working databases of your master database for different battlegroups. This is a particular advantage since the composition of each battle group will be different and there is no need to keep systems that are not in the battle group.

Please do not confuse your master database with the master database created by us.

Add To Current Database Using Master

In your daily workings, you may have a need to add a system to your working database. Rather than entering the EM system values via one of the system windows, you may use this menu item to "bring in" a system from a master database you maintain or from a database provided to you from another AREPS user. By choosing the menu item, the modify database window, figure 6-3, will open allowing you to sort your master and current database, search for a system or target in the databases, and populate or delete items from your current database.

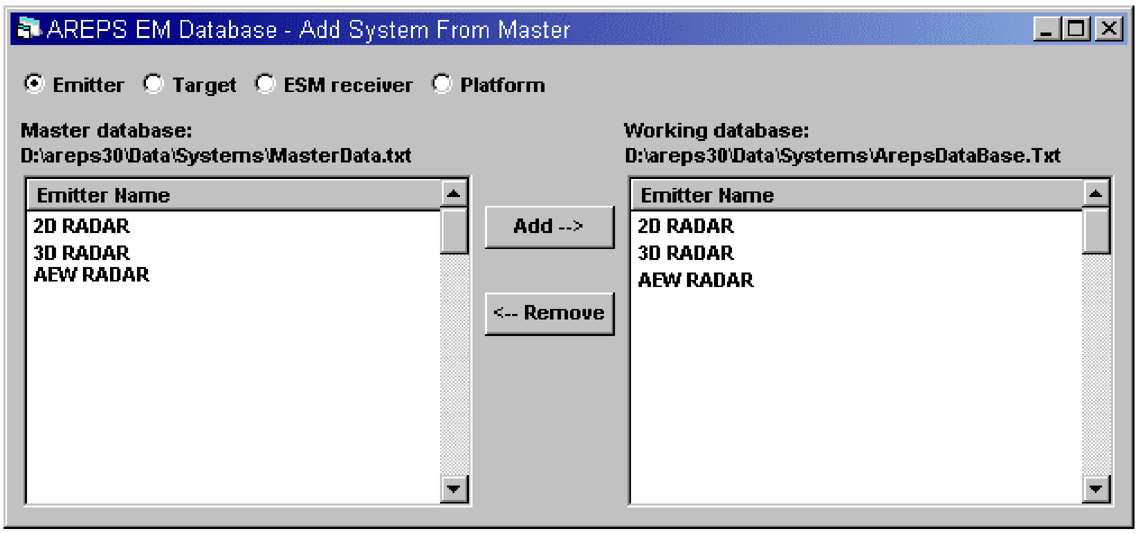


Figure 6-3: Modify database window.

The contents of the master database show in the selection box to the left of the window. The contents of your working database show in the selection box to the right of the window. Click any option button above the selection boxes to change the section of the database you want to work with.

You may highlight a master system by left clicking on its name. By holding down the Ctrl key while clicking on system names, more than one system may be selected at a time. By clicking on a name, holding down the Shift key, and then clicking on another name, all the systems between the two clicked names will be selected. Once all the desired systems are highlighted, just click the Add command button and the systems will immediately be added to your working database. The master database remains unaffected. By highlighting a system from your working database and clicking the Remove command button, the system will immediately be removed from your working database.

Either database may be sorted by clicking on the title bar for each item type. For example, to sort by emitter name, click on the title bar that says "Emitter name." Clicking on the title bar again will sort the column in reverse order.

Note there is no Cancel button. All changes made to your working database are immediate. However, your working database file will not be saved until you exit AREPS. Should you delete a system from your working database by accident, you must say No when you are asked if you want your database saved. Either that or you may add it from the master, assuming it is in the master database, or entering the data over again from the appropriate system window. The platform section of the database and the emitter section are linked together. Should you delete a particular radar system from your working database, it will also be deleted from all the platforms containing it.

By right clicking on a system name, its entire data may be displayed in a general-purpose list window. From the list window, the data may be saved in an individual file, printed, or copied to the clipboard.

Convert AREPS 2.X Database to 3.0 Format

Beginning with AREPS version 3.0, we changed the format of the EM system database used by AREPS from the Microsoft Access format to ASCII text format. We did this for a number of reasons. The first is speed. It's much faster to read the entire database into memory than it is to use the calls of Microsoft Access for an individual entry. The second is ease of distribution. We don't have to include any of the Microsoft Access dynamic link library files. The third is readability. Simple ASCII text files can be viewed without any database supporting files. It's clear, understandable, and there is no need to provide any binary "format" description to others that may want to use the database. Lastly, we don't have to be dependent upon Microsoft and thus don't have to worry about them changing the way things are done (like going from Access 98 to Access 2000).

With the format change, we provide a utility program to convert any AREPS 2.X *.mdb files you may have into the AREPS 3.0 format.

The conversion program assumes you have an AREPS 2.X program already installed on you system. This is because the conversion program requires the Microsoft Access dynamic link library files to operate and these files are no longer distributed with AREPS 3.0. In addition, this conversion program will only function with Access 95/97 files and not with Access 2000 files.

There are only three simple conversion steps. First, **open** an AREPS 2.X *.mdb file from the File menu, figure 6-4. Once selected, the program will automatically open the file, convert the data, and display a summary of the results, figure 6-5. Secondly, S**ave** the file from the File menu, figure 6-4. Lastly, **Exit** the program from the File menu. Because this utility is an executable program, it may be run independently from AREPS. The program's name is Areps30DbConvert.exe and it is located in the AREPS bin folder.

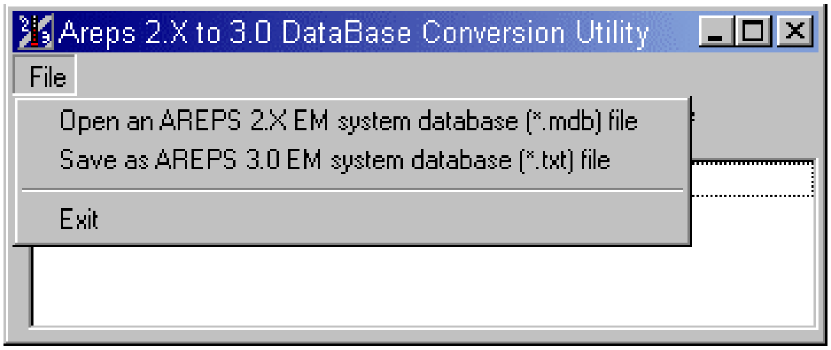


Figure 6-4: Open an existing database file

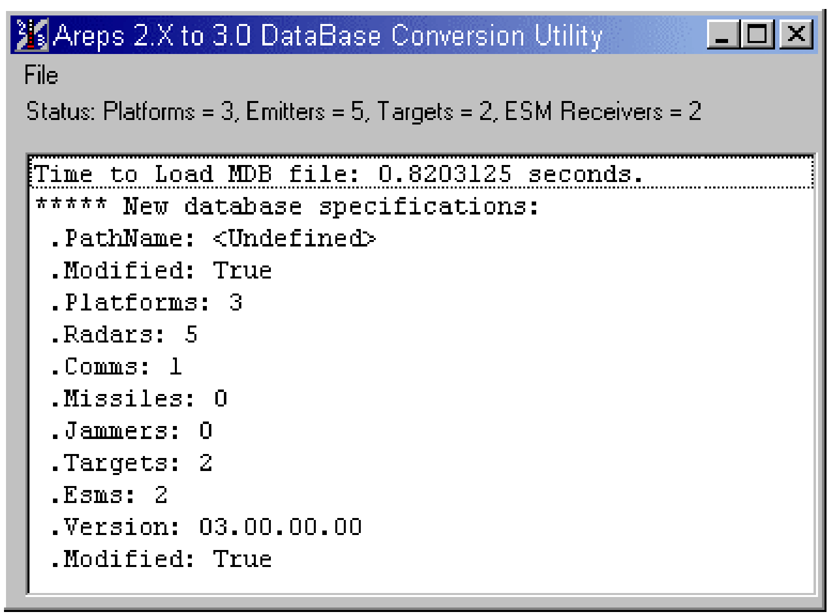


Figure 6-5: Database format conversion statistics.

EM Database File Format

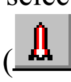
The format of the file is the same as that used by Microsoft in their initialization files and the same as all other AREPS ASCII text files. There are sections identified by name inside square brackets [] and within each section, there is a variable name, an equals sign, a data value, and optionally, a comment proceeded by the # sign. The section identifiers are Database Info, Platform, Emitter, Target, and ESM. A sample format is below.

```
[AREPS DataBase]          # Areps30  January 07 2002 07:22:32

[DataBase Info]
Comms        = 0           # Number of emitters that are Comm type
Created      = "1/7/2002 7:22:10 AM"   # Date created
Creator      = "Areps30 03.00.0000"    # Who generated file
Emitters     = 1                       # Total number of emitters
Esms         = 1                       # Number of ESM data sets
FileDate     = "1/7/2002 7:22:12 AM"   # Last time file updated.
Jammers      = 0         # Number of emitters that are Jammer type
Missiles     = 0         # Number of emitters that are Missile type
ModifiedDate = "1/7/2002 7:22:12 AM"     # Last updated
PathName     = "C:\Program files\AREPS\Data\Systems\ArepsDataBase.Txt"
Platforms    = 1         # Number of platforms
Radars       = 1         # Number of emitters that are Radar type
Targets      = 1         # Number of targets
Version      = "03.00.00.00"     # Version of database

# Number of platforms: 1

[Platform]
Name        = "Ship"     # Name of Platform
Class       = "0"        # Security classification [0 1 2 3]
Type        = "Mobil"    # Type of platform (Mobile, Stationary)
Lon         = "  0 E"    # Longitude
Lat         = "  0 N"    # Latitude
HtRef       = "Mean sea level"   # Antenna ht reference
Emitters    = "1"        # Number of Emitters
Emitter(0)  = "3D RADAR" # Emitter name
AntHt(0)    = "75", "ft" # Antenna height

# Number of Emitters: 1

[Emitter]
Name          = "3D RADAR"      # Name of emitter
EmitterType   = "Radar"         # Type of emitter
AltID         = "            "  # Alternate ID
AntennaGain   = "39", "dbi"     # Antenna Gain
AntennaType   = "Height finder" # Antenna type
AntScanRate   = "0", "rpm"      # Antenna Scan Rate
Class         = "0"             # Security classification [0 1 2 3]
ElevAngle     = "0.5", "Deg"    # Elevation Angle
FalseAlarms   = "1E-08"         # False Alarms
Freq          = "3000", "MHz"   # Frequency
```

```
HitsPerScan   = "1"              # Hits Per Scan
HorzBeamWidth = "0", "Deg"       # Horizontal Beam Width
MaxInstRange  = "250", "km"      # Maximum instrumented Range
Polar         = "Horizontal”     # Polarization
Power         = "2000", "kW"     # Power
ProbOfDet     = "0"              # Probability of detection
PulseComp     = "0", "µs"        # Pulse Comp
PulseLen      = "9", "µs"        # Pulse Length
PulseRate     = "0", "Hz"        # Pulse Rate
RadarCalc     = "Incoherent"     # Radar Calculations type
RecNoise      = "5.5", "dB"      # Receiver Noise
RecSens       = "0", "dbm"       # Receiver Sensitivity
SystemLoss    = "3", "dB"        # System Loss
VertBeamWidth = "1.5", "Deg"     # Vertical Beam Width
AngleFactors  = "0"              # Number of Antenna pattern factors.
JammerFreqs   = "0"              # Number of Jammer frequency entries.
FreeSpaces    = "0"              # Number of Free space entries.

# Number of targets: 1

[Target]
Name            = "MEDIUM JET"   # Name of target
Class           = "0"            # Security classification [0 1 2 3]
TargetType      = "Other"        # Target Type
SwerlingCase    = "Flucuating"   # Swerling case
Count           = "6"            # Number of Target data parameters
Polar(0)        = "Horizontal"   # Polarization
Freq(0)         = "900", "MHz"   # Frequency
CrossSection(0) = "10", "sqm"    # Radar cross section
Polar(1)        = "Horizontal"   # Polarization
Freq(1)         = "3000", "MHz"  # Frequency
CrossSection(1) = "12", "sqm"    # Radar cross section
Polar(2)        = "Horizontal"   # Polarization
Freq(2)         = "10000", "MHz" # Frequency
CrossSection(2) = "14", "sqm"    # Radar cross section
Polar(3)        = "Vertical"     # Polarization
Freq(3)         = "900", "MHz"   # Frequency
CrossSection(3) = "15", "sqm"    # Radar cross section
Polar(4)        = "Vertical"     # Polarization
Freq(4)         = "3000", "MHz"  # Frequency
CrossSection(4) = "13", "sqm"    # Radar cross section
Polar(5)        = "Vertical"     # Polarization
Freq(5)         = "10000", "MHz" # Frequency
CrossSection(5) = "15", "sqm"    # Radar cross section

# Number of Esms: 1


[ESM]
Name           = "RECEIVER A"   # Name of ESM receiver
Class          = "0"            # Security classification [0 1 2 3]
Polar            = "Circular"     # Polarization [Horizontal, Vertical,
Circlular]
AltID          = "            " # Alternate ID
Count          = "5"            # Number of ESM data parameters
LowerFreq(0)   = "100", "MHz"   # Lower frequency
UpperFreq(0)   = "1000", "MHz"  # Upper frequency
```

```
Sensitivity(0) = "-85", "dbm"    # Sensitivity
LowerFreq(1)   = "1000", "MHz"   # Lower frequency
UpperFreq(1)   = "3000", "MHz"   # Upper frequency
Sensitivity(1) = "-82", "dbm"    # Sensitivity
LowerFreq(2)   = "3000", "MHz"   # Lower frequency
UpperFreq(2)   = "6000", "MHz"   # Upper frequency
Sensitivity(2) = "-80", "dbm"    # Sensitivity
LowerFreq(3)   = "6000", "MHz"   # Lower frequency
UpperFreq(3)   = "10000", "MHz"  # Upper frequency
Sensitivity(3) = "-78", "dbm"    # Sensitivity
LowerFreq(4)   = "10000", "MHz"  # Lower frequency
UpperFreq(4)   = "20000", "MHz"  # Upper frequency
Sensitivity(4) = "-79", "dbm"    # Sensitivity
```

Platform Editor

The platform editor, figure 6-6, opens by selecting **New Platform** from the **System** menu, or by clicking the platform editor () toolbar button. To open an existing platform, select the **Open/Remove** Platform item from the **System** menu. When the selection window opens, double click on the name or click the **Open** button. To remove a platform or platforms, highlight those you intend to remove and click the **Remove** button. If more than one platform is highlighted, you will receive a confirmation notice. Refer to navigating the AREPS windows for a general discussion of data input, editing, etc.

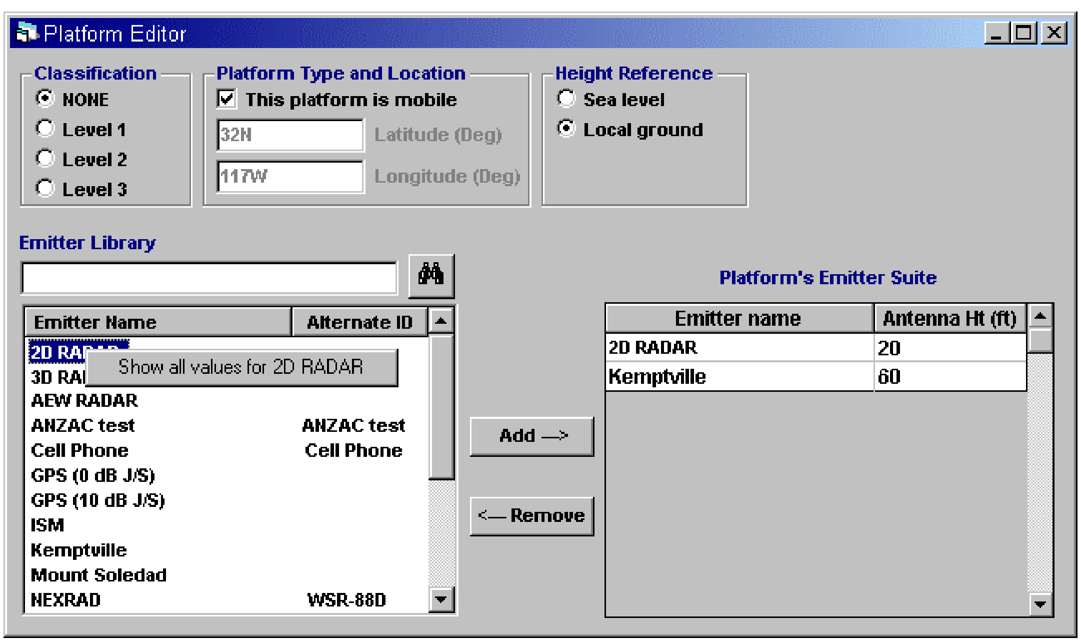


Figure 6-6: Platform editor.

Platform Type and Location Grouping

A platform or a site is a container for an emitter such as a radar or a radio. A platform is generally thought of as a container that is mobile such as a ship, aircraft, or tank. A site is generally thought of as a container that is either fixed or semi-fixed in location such as a communications bunker or a surface-to-air missile emplacement.

If the platform is mobile (i.e., ship, plane, tank, etc.), check this box. The platform's latitude and longitude input fields become unavailable. If the platform is stationary (i.e., a communications bunker, etc.), uncheck this box. The latitude and longitude input fields become available. When this platform is selected for a project, and the platform is stationary, its location will automatically be copied to the project. You have the option to override the location from the project window if you choose to do so.

The latitude and longitude value may be entered in degrees, minutes, and seconds. The format may be decimal numbers or integer numbers separated by a space. For example, if you enter 36.5 and then press the Enter key or leave the input box, the field will change to 36º30'. You may also enter a decimal value for both the minutes and the seconds. For example, if you enter 32.5 degrees 16.3 minutes, and 17.5 seconds, the field will change to 32º46'36".

When entering latitude and longitude values, you must also specify a quadrant. This may be W for west, E for east, N for north or S for south. When both lower and upper bounds of an input field are in the same quadrant, AREPS will automatically select the quadrant and enter it for you so you don't have to type it yourself. If the bounds are in different quadrants, you must enter it. If you don't, the default is east longitude and north latitude. For those uses exclusively in the southern or western hemispheres, the default can be an annoyance. Thus, you can choose to have the default hemispheres other than Northeast. Once set from the **Program flow** item on the **Options** menu, you no longer need to type the quadrant into the field.

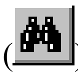
Antenna Height Reference Level

APM requires a reference level for antenna height considerations. The reference level may be the local ground level or mean sea level. For example, a land-based system mounted on a truck may use local ground level as the reference level, a shipborne system may use mean sea level as the reference level, and an airborne system may use either. When this platform is selected for a project, its reference heights automatically transferred into the project's reference height options buttons. You may override the reference height in the project window.

Emitter Library

The emitter library is a listing of all emitters in your current database. Use the list scroll bars to view all the emitters. If the entire emitter name is not visible (the name ends with …), click and drag the vertical line in the column label to expand the column width.

To select an emitter, click on its name or use the navigation keys to position the cursor over its name and then press the **ENTER** key. By holding down the **Ctrl** key while clicking on system names, more than one system may be selected at a time. By clicking on a name, holding down the **Shift** key, and then clicking on another name, all the systems between the two clicked names will be selected. Once all the desired systems are highlighted, just click the **Add** command button and the systems will be added to your platform. The emitter names may be sorted in alphabetical order by clicking on the name label. Clicking the name label a second time will sort the names in reverse alphabetical order.

As a convenience, you may search for a system by entering a system name into the search input box and then pressing the ENTER key or clicking the search () button.

By right clicking on an emitter's name, its entire data may be displayed in a general-purpose list window. From the list window, the data may be saved in an individual file, printed, or copied to the clipboard.

Platform Emitter Suite

The platform's emitter suite is a listing of all emitters currently on your platform. The first column shows the emitter name. The second column shows the height of the emitter's antenna. The height is relative to the reference level you select. To change height units, right click on the column's label and choose your new units from the popup menu.

When a platform is selected from the Project window, the emitter names within the suite will be copied into the Radar/Comm drop-down menu for your selection. For additional information about the link between the platform's emitter suite and the Radar/Comm drop-down menu, see the Program Flow item on Options menu.

Also, when a platform and radar combination is selected from the Project window, the emitter's antenna height entered here in the platform window is copied into the antenna height field of the project and the associated reference level is selected. You may change the antenna height and reference level from the project window.

Command Buttons

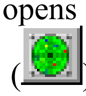
Add Emitter

A listing of all emitters in your current database is shown in the emitter library list. To add a particular emitter to your platform's suite of emitters, highlight its name and then click the Add button.

Remove Emitter

A listing of all emitters in your current platform's suite is shown in the suite list. To remove a particular emitter from your platform's suite of emitters, highlight its name

Radar Editor

The radar editor, figure 6-7, opens by selecting **New Radar** from the **System** menu, or by clicking the radar editor () toolbar button. To open an existing radar, select the Open/Remove Radar item from the System menu. When the selection window opens, double click on the name or click the Open button. To remove a radar or radars, highlight those you intend to remove and click the Remove button. If more than one radar is highlighted, you will receive a confirmation notice. Refer to navigating the AREPS windows for a general discussion of data input, editing, etc.

Radar Calculations/Type

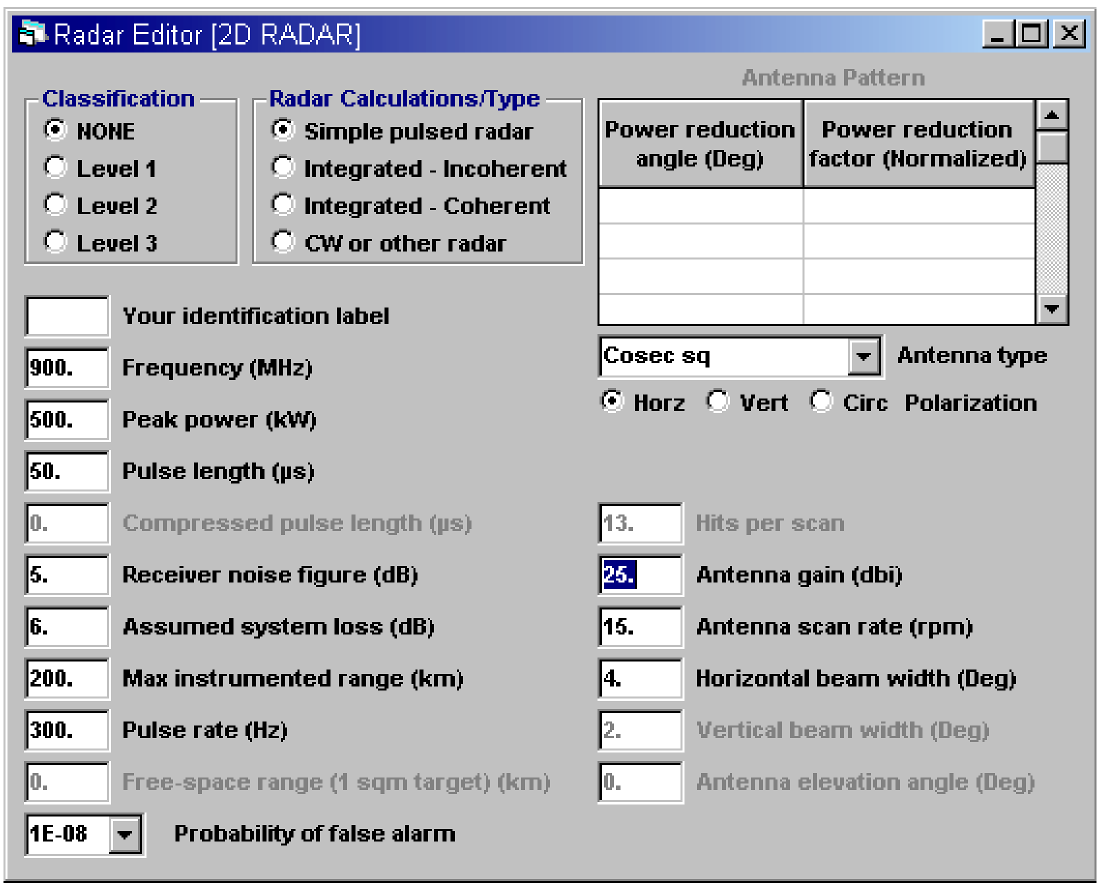


Figure 6-7: Radar editor.

Determining a detection threshold is a complicated issue requiring knowledge of many system parameters. AREPS considers two types of radars, pulsed radars and other radars. Other radars are either CW radars or radars for which you do not know all of the system parameters necessary for a probability of detection calculation.

By selecting one of these calculation types, AREPS makes available to you the input fields, dropdown boxes, and option buttons appropriate to your radar. For example, a simple or integrated calculation type (a pulsed radar) will offer an "inactive" free-space range input field and a false-alarm rate dropdown menu while the CW or other radar type will offer an "active" free-space range input field and an "inactive" false-alarm rate dropdown menu.

If you are creating a CW or other system, please make sure you read and understand the significance of the free-space range input value.

For pulsed radars, detection of a target requires the receiver output, which consists of signal and noise, be processed in such a way that true signal detection is of high probability and that false signal detection (due to noise or jamming) is of low probability.

The probability of detection is determined by the amplitude distribution (envelope) of the signal plus the unwanted noise or jamming. To improve the probability of true signal detection, pulse integration (the adding of target return signals and noise from two or more successive transmit pulses) is often times performed. The advantage of pulse integration is that the true signal often does not change very fast (within a 10th of a second or so) whereas noise, a random process, often changes from pulse to pulse. Therefore, using integration normally allows the true signal to grow in strength (giving a better probability of detection), whereas the noise typically decreases in strength (its average value is zero).

There are two types of radar signal integration, coherent and incoherent. Radar signals are said to be coherent when the relative phase of the signals have a known relationship even though they may be considerably separated in time. Coherent integration is the addition of coherent radar signals (signals in relative phase) prior to determining the detection envelope. Incoherent integration does not consider the signal's phase but examines only the amplitude of each individual pulse. Once the amplitude information is extracted for each pulse, the information is then summed. Coherent integration increases the probability of detection more rapidly than incoherent integration, but coherent integration is normally more expensive to implement.

AREPS allows for the calculation of a detection threshold based upon coherent integration, incoherent integration, or no integration (simple).

EM System Parameters

Your Identification Label

The identification label is an optional field for your own use in organizing your radar systems. This label shows in the **Details** view of the Open/Remove window. By clicking on the column title bar, your radars will be sorted by this label, allowing you another way to quickly find a particular radar. You may use any label format you desire but the label is limited to 12 characters.

Frequency

Frequency is the rate of recurrence of an event in periodic motion. The frequency is defined as the speed of light propagating through the atmosphere, divided by the wavelength of the transmitted energy. For radars and communications systems, this data input is the frequency of the transmitter. For a target, it is the frequency corresponding to the measured radar cross-section. For an ESM receiver, it is the upper and lower frequencies associated with a particular receiver band.

The recommended limits for all frequencies are 100 to 20,000 MHz. The units may be MHz or GHz. While the parabolic equation technique of APM is capable of higher frequencies, we have set a hard upper limit of frequency to 57 GHz. This is because APM version 1.0 has only implemented the gaseous absorption model up to that frequency.

Peak Power

For a radar application, the peak power is the maximum instantaneous power generated in a single pulse by the transmitter. Do not include transmission line or other losses. Do not use average power. For a communication application, use the average power.

Pulse Length

In nature, energy is typically transmitted in the form of a simple sine wave. A radar transmitter will generate, in short bursts or pulses, this sine wave and then vary (or modulate) its frequency or phase, thereby shaping the waveform. A shaped waveform will increase the information that may be obtained from the return echo. The pulse length is the length of time between the start and end of the pulse. Long pulse lengths have the advantage that large amounts of energy can be applied to a target in order to enhance its detectability. Long pulse lengths will lead to the longest range of detection and are, therefore, used in long-range search radars. Long pulses have the disadvantage that fine details within the return echo are lost, thereby reducing target resolution. For example, a long pulse length may be used to detect the presence of a harbor within a coastline but will be unable to detect a pier within the harbor.

Compressed Pulse Length

Many receivers perform sophisticated signal processing to aid in identifying a true target or gaining additional information about the target. One such technique is called pulse compression. By modulating a wave's frequency or phase, the echo may be compressed in time by the receiver. Pulse compression achieves the benefit of high target resolution that comes from using a short pulse length yet uses the energy of a long pulse, gaining longer-range detectability. In addition, pulse compression also reduces the influence of clutter.

Receiver Noise Figure

The receiver noise figure (most accurately described as a system noise figure) is a measure of the receiver system's noise temperature. The temperature relates to thermal noise in the receiver circuit, non-thermal noise from the electronic components, and antenna noise from environmental sources. The noise figure is defined by the ratio (in decibels) of the system noise temperature in Kelvin to 290° Kelvin (the IEEE standard reference temperature).

Assumed System Loss

The system loss is the sum of all losses that affect the radar free-space range calculations. These include, but are not limited to, transmission line loss, beam shape (or antenna pattern) loss, filter mismatch loss, bandwidth correction factor loss, signal processing loss, collapsing loss, etc.

Maximum Instrumented Range

After the transmitter sends out a pulse, it turns off and allows the receiver to "listen" for an echo. It may happen that a pulse will travel to a target and back, only to arrive while the transmitter is in the process of sending out another pulse. In such an event, the pulse is not received and the target is not detected. It may also happen that the pulse will return at some time after the transmitter has sent out a second pulse. In that circumstance, the target will appear closer to the transmitter than it really is. Echo signals received after an interval exceeding the pulse repetition period are called "multiple-time-around" echoes or "radar ghosts." The range that a pulse can travel to the target and back in the time interval between pulses is known as the maximum-instrumented range or the maximum unambiguous range.

Pulse Rate

The pulse rate is the number of pulses the transmitter generates each second.

Free-space Range

For assessment of radar performance, the most important factor to consider is the radar's free-space detection range or, in other words, the range at which a specific target may be detected in an isotropic, homogeneous, lossless environment. This range serves as an optimum range (or figure of merit) for a particular radar/target combination and allows for a comparison with nonstandard refractive conditions.

The free-space range may be determined in several ways, the first being by calculation. The free-space range is calculated by AREPS when you select a pulsed radar system. For other radars however, like CW radars, some of the parameters needed for the calculation are not applicable. Also, the calculation for free-space range involves a number of uncertainties and may lead to an overly optimistic range.

For systems where the calculations do not apply (or for pulse systems where you do not know all the necessary calculation parameters), you may enter the free-space range directly. The units may be in nautical miles, kilometers, or as a threshold in decibels.

Because AREPS allows varying target sizes and there is only one free-space range input parameter, AREPS needs to perform scaling. In order to do this; the free-space range you enter must be associated with a target size of **1 square meter**. This then will allow AREPS to scale to the particular size of the target you select from the target dropdown menu.

It may be you don't have or know the free-space range for a target of one square meter but you do know the free-space range for a target of say, 10 square meters. In this case, enter the free-space range value you know and then create a new "reference" target, using one square meter as its radar cross-section. Just remember not to select this "reference" target when using a pulsed radar system.

Often, you may obtain the free-space range from the system's operating manual. The most accurate method of determining the free-space range however, is by observation of the maximum detection range of known targets at angles above a few degrees from the horizontal, where effects of refraction are minimized? In the case of surface-based 2D air-search radar systems, the free-space detection range is one-half the maximum observed range at high altitudes because of the influences of the interference region. For surface-based height-finder and all airborne radar systems, the free-space detection range is the maximum observed range at high altitudes.

Probability of False Alarm

Receivers are designed with a high enough detection threshold that most receiver noise will not exceed it. On occasion, however, noise will have sufficient power to exceed the threshold, resulting in a false alarm. A tolerable rate at which false alarms occur depends upon the nature of the radar application. False alarm probabilities for most practical radars are quite small, on the order of 1.0E-6 or smaller.

Antenna Pattern

The distribution of energy into space relative to the antenna's axis of symmetry is called the "antenna pattern," its "power pattern," or its "radiation intensity pattern." While the distribution of energy is three dimensions, it is most commonly displayed as a series of two-dimensional planar patterns. The major concentration of energy is along the axis of symmetry and is known as the main beam or "lobe." The main beam width, both horizontally and vertically, is most commonly expressed in degrees and represents the half-power points in the pattern. The additional lobe structure of the antenna pattern outside the region of the main beam is called "sidelobes." Sidelobes cause problems in target detection because they allow energy from outside the desired direction to enter the system. This leads to false targets or increased susceptibility to radar jamming.

For height-finder radar applications, it is desirable to reduce the power output at higher beam elevation angles or, conversely, increase the power output for lower beam elevation angles. Height-finder radars commonly employ antennas that steer the transmitted energy upward in angle. While the power necessary to detect a target 200 miles away in the horizontal is desired, the same power directed upward at 30 degrees would detect a target at approximately 530,000 feet. Since targets are not expected at this height, the power of the transmitter is reduced as the elevation angle increases. In addition, there is a reduction in how long the receiver waits for a radar echo. This has the advantage of reducing the strain on the transmitter and allows for better utilization of the radar's time. For the HT-FINDER SPECIFIC antenna pattern, you must specify the angle at which the power is reduced and the factor by which the power is reduced.

A user-defined antenna pattern is a non-height finder pattern you define yourself. To define the pattern, you must specify a radiation angle (degrees or milliradians) and an associated pattern factor (normalized to 1 or in dBi from 0 to -100). The zero angle is at the center of the main beam and, at this zero angle, the pattern factor must be 1 or the relative gain 0 dBi. AREPS will assume the pattern remains constant beyond the lowest and highest angle. This is, if your highest entered angle and pattern factor is 20 degrees and -30 dBi, the pattern will be -30 dBi for all angles greater than 20 degrees. In a like manner, if your lowest entered angle and pattern factor is -10 degrees and -40 dBi, the pattern will be -40 dBi for all angles less than -10 degrees. Since you may specify the pattern from -90 degrees to 90 degrees, you may include the effects of all side lobes.

For your convenience, AREPS allows you to retrieve your specific height-finder and user defined antenna pattern from an ASCII text file rather than requiring a keyboard entry. You may use this feature by right clicking on the antenna pattern tabular form and choosing Read antenna pattern from file option. The antenna pattern file must follow the AREPS conventions. These conventions are:

(a) The antenna pattern file must be an ASCII text file, consisting of two distinct columns of numbers. The first column must be angle values and the second column must be factor values. The columns may be separated with white spaces, commas, semicolons, or TAB characters.

(b) The order of values within a column is not important, as AREPS will automatically sort both columns by angle, from low to high.

(c) AREPS recognizes certain designators to define the antenna type, angle units and factor units. In the absence of these designators, AREPS assumes an user-defined antenna pattern, angles units of degrees, and factor units of dBi. The format of these designators is a keyword, followed by an equal symbol (=) and then the value for the keyword. It is not necessary to include spaces around the equal sign. If the value contains spaces, the entire value must be enclosed in quote marks ("). These designators are:

AntennaType = "User defined" # Antenna type
AntennaType = "Specific height finder" # Antenna type
AngleUnits = mrad # Angle in milliradians
AngleUnits = deg # Angle in degrees
FactorUnits = dbi # Factor in decibels relative to an isotropic antenna
FactorUnits = normalized # Factor normalized to unity (1)

(d) Any line beginning with a # or any text following a # is considered a comment and is ignored. It is not necessary to include comments. In addition, blank lines are ignored.

During the reading process, AREPS will not error check the angle and factor values. Any error messages will happen when the tabular form loses the focus. For example, if your antenna type is a specific system height finder but your values are for a user-defined antenna type, many or all of the angle or factor values could be out of bounds. If the entire tabular form is in error, you may use the tabular form clear toolbar button () to remove all the values so you won't continue to receive multiple error messages. You may then edit your file off-line from AREPS, putting in the appropriate antenna type, and then re-read the file.

An example of an antenna pattern file is:

```
AntennaType = "User defined"
AngleUnits = deg
FactorUnits = dbi
-4.55                                                  -20
-4.35                                                  -18
-4.23                                                  -17
-4.1                                                   -16
-4                                                     -15
-3.88                                                  -14
-3.76                                                  -13
-3.63                                                  -12
-3.48                                                  -11
-3.33                                                  -10
-3.17                                                   -9
-2.97                                                   -8
-2.75                                                   -7
-2.55                                                   -6
-2.35                                                   -5
-2.12                                                   -4
-1.85                                                   -3
-1.49                                                   -2
-1.05                                                   -1
-0.77                                                 -0.5
```

-0.55	-0.25
-0.001	0
0	0
0.001	0
0.53	-0.25
0.73	-0.5
1.05	-1
1.53	-2
1.85	-3
2.25	-4
2.633	-5
3.22	-5.7
4.93	-5.5
6.33	-6
8	-6.35
9.33	-7.3
10.66	-7.15
12.83	-8.2
14	-7.85
15.7	-8.75
17.75	-8
20	-9.1

Antenna Type

The antenna type provides a description of the radiation pattern of the transmitter or radar antenna. The antenna types as used in AREPS are given in table 6-1.

Table 6-1: Antenna types.

OMNI	Uniformly radiating in all directions
SINX/X	See **Elevation angle** for additional information
CSC-SQ	Cosecant-squared radiating pattern
GAUSSIAN	Gaussian radiating pattern
HT-FINDER GENERIC	Height-finder that vertically scans a SINX/X pattern
HT-FINDER SPECIFIC	Height-finder with a radiating pattern defined by the radar itself like the AN/SPY-1B or the AN/SPS-48E. It may also be a specific height finder with an antenna pattern you define yourself. This specific height finder vertically scans a SINX/X pattern but, unlike the generic height finder, has power reduction factors as a function of scanning angle.
USER DEFINED	A non-height finder radar or communication system with an antenna pattern you define yourself.
QUARTER-WAVELENGTH VERTICAL DIPOLE	The QWD antenna can be used in two situations. First, if you have a base-fed vertical 'whip' antenna whose physical length is about 1/4 of the wavelength at the operational frequency. You can also use this antenna if you have a 1/4 wavelength matching network at the base of your antenna, whatever its physical length. This antenna can also be used for a n/2 wavelength long (physical length) vertical dipole antenna, where n = 1,2,3,4, etc.

Polarization

Polarization is the orientation of the antenna's electric field, which may be parallel to the earth’s surface (horizontal), or perpendicular to the earth’s surface (vertical). The polarization may also be elliptical or circular. Elliptical polarization is the combination of two linearly polarized waves of the same frequency, traveling in the same direction, which are perpendicular to each other. The relative amplitude and phase relationships between the two may be of any value. If the two wave amplitudes are equal and they are 90 degrees out of phase, the polarization is circular. For the target, the polarization corresponds to a measured radar cross-section.

Hits Per Scan

In order to detect a target, an acceptable signal-to-noise ratio must be obtained. One way to accomplish this is to apply more energy on the target. Applying more energy on the target may be accomplished by increasing the number of pulses striking the target as the radar beam scans over the target. For simple radars, the number of hits per scan is calculated from the antenna's horizontal beam width, the pulse repetition frequency, and the horizontal scan rate of the antenna. For other types of radars, the number of hits per scan must be specified explicitly.

Antenna Gain

The ability of an antenna to concentrate energy into a particular pattern or be more sensitive to energy arriving from a specific direction is called antenna gain. The gain of the transmitting antenna is a function of the antenna's aperture (the physical area of the antenna face), any losses of energy from processes such as resistance and radiational heating, and the wavelength. As the aperture of the antenna increases, the wavelength of energy decreases and the antenna gain increases. Greater antenna gains, of course, mean better target detection. While most radars are fixed in size and, therefore, have fixed gains, it is possible to use the relative motion between the radar and the target to electronically increase the aperture of the radar, thereby improving the gain and resolution. These radars are called "synthetic aperture" radars (the motion of the radar is used to increase the gain) or "inverse synthetic aperture" radars (the motion of the target is used to increase the spatial resolution.

Antenna Scan Rate

The antenna scan rate is the transmitter's antenna rotational or horizontal turning rate.

Horizontal Beam Width

The horizontal beam width is the horizontal angular width between half-power points of the antenna's main beam.

Vertical Beam Width

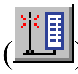
The vertical beam width is the vertical width of the antenna's main beam. For SINX/X, GAUSS, and HT-FINDER, the beam width is the full angular width between half-power points. For CSC-SQ, the beam width is the angular region where the pattern is uniform and above which a cosecant-squared function is applied.

Antenna Elevation Angle

The antenna elevation angle is the boresight-pointing angle for SINX/X and GAUSS antenna types. It is also the direction of the maximum radiated power. For the HT-FINDER (GENERIC) antennas, the elevation angle is the angle above which the

SINX/X pattern is vertically scanned. The elevation angle is measured from the local horizontal and increases in an upward direction. For most surface-based systems, this angle will be zero. For many airborne radars, this angle will be slightly downward (negative elevation angle).

Communication Editor

The communication editor, figure 6-8, opens by selecting **New Communication** from the **System** menu, or by clicking the communication system editor () toolbar button. To open an existing communications system, select the Open/Remove Communications item from the System menu. When the selection window opens, double click on the name or click the Open button. To remove a communications system, highlight those you intend to remove and click the Remove button. If more than one communications is highlighted, you will receive a confirmation notice. Refer to navigating the AREPS windows for a general discussion of data input, editing, etc.

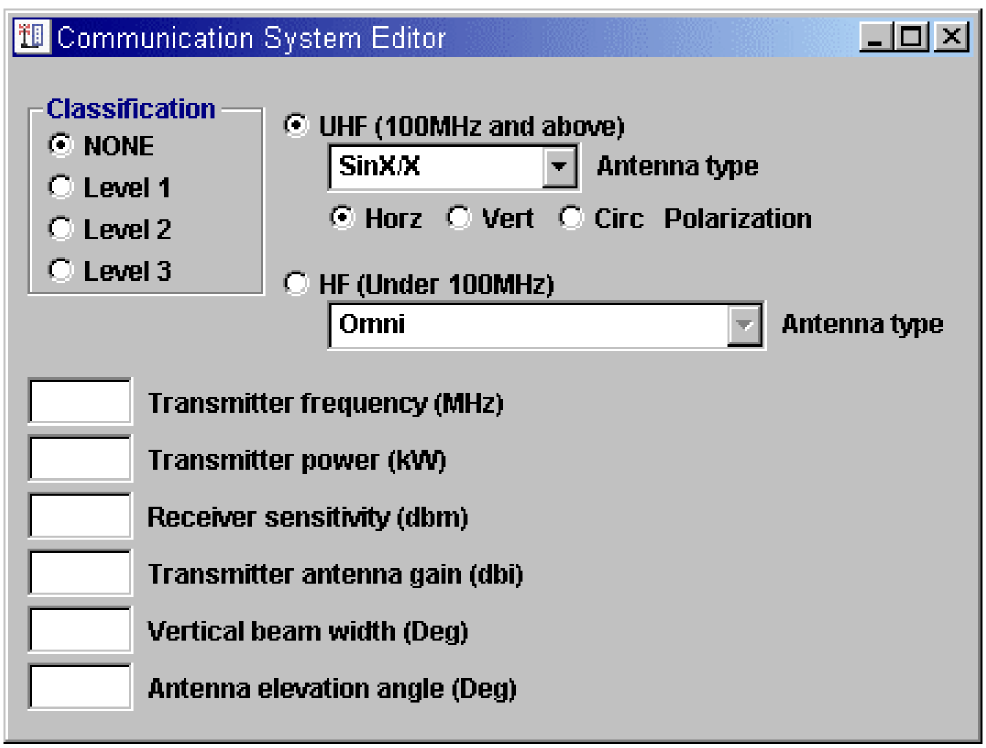


Figure 6-8: Communication editor.

Receiver Sensitivity

The receiver sensitivity is the measured or specified ESM or communication receiver's sensitivity in decibels above a milliWatt (dBm). For ESM receivers, each frequency range and polarization combination will have its own sensitivity. Sensitivity values are normally negative. A typical good ESM sensitivity for microwave frequencies is -80 dBm. The radar and ESM receiver parameters will determine the receiver sensitivity used for the project. If the radar and ESM receiver do not have the same polarization, the sensitivity will be reduced by 3 dB for horizontal or vertical polarization radar and circular polarization receiver, or by 15 dB for horizontal polarization radar and vertical polarization receiver (or vice versa).

High Frequency (HF)

The surface wave is a non-homogeneous electromagnetic wave that is generated when an electromagnetic wave is incident at near-grazing angles on an impedance boundary, such as the air and earth or sea-water boundary. It propagates independently of the direct wave and earth-reflected wave. The propagation of the surface wave is highly dependent on the dielectric properties of the boundary medium. For example, the wave is stronger over sea- water at high frequencies (2-30 MHz) than at microwave frequencies. This can also be important over other ground types (dry ground, for example) at HF frequencies.

Typically, the surface wave is only important for vertically polarized waves and will only be considered for such waves here. The effects of the surface wave fall off exponentially with height above the boundary surface and may be significant only at several wavelength heights.

To meet an accelerated delivery schedule for HF (2 to 99 MHz) surface wave assessment, a limited capability requiring certain assumptions has been implementation in this version of AREPS. Future versions of AREPS will increase the capabilities for HF assessment and overcome the assumptions. The current assumptions or limitations are:

1. HF for AREPS is defined as being between 2 and 99 MHz.

2. HF is for communications only. No HF radar assessment is available.

3. HF is for surface wave propagation assessment only. There is no consideration of HF skywave propagation and all its implications with the ionosphere.

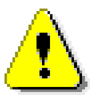
4. No signal-to-noise or other system threshold calculations are made. Thus, the only decision aid available is the vertical coverage display and the range/height display of propagation loss or propagation factor. You must have some foreknowledge of signal levels you require for communications.

5. The antenna type may only be Omni or Quarter-wavelength Vertical Dipole. If the frequency is between 50 and 99 MHz, only the Omni antenna type is allowed.

6. The antenna polarization may only be vertical.

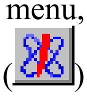
7. Troposcatter is not considered in the propagation loss calculations.

8. The atmospheric specification may only be standard. There are still some research questions regarding a single gradient atmosphere at high elevations and long ranges. As these questions are resolved, the atmospheric description will be refined.



9. The propagation effects of the surface wave below 10 MHz produce results that appear different (or strange) than those at higher frequencies. This is particularly true for over water paths where there are strong interference interactions within the wave. While we feel the model has been implemented correctly and the results are physically real rather than created by some numerical instability in the model, there are still some questions. If your frequency is below 10 MHz, you will receive this warning notice prior to AREPS execution.

ESM Editor

The ESM editor, figure 6-9, opens by selecting **New ESM** from the **System** menu, or by clicking the ESM system editor () toolbar button. To open an existing ESM receiver, select the Open/Remove ESM item from the System menu. When the selection window opens, double click on the name or click the Open button. To remove an ESM receiver, highlight those you intend to remove and click the Remove button. If more than one ESM receiver is highlighted, you will receive a confirmation notice. Refer to navigating the AREPS windows for a general discussion of data input, editing, etc.

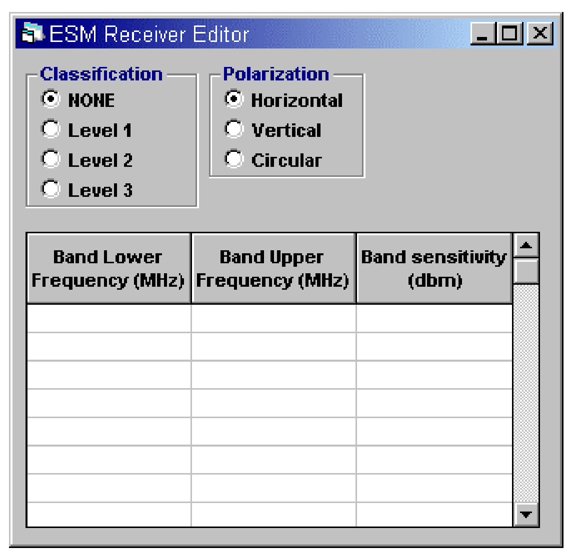


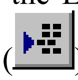
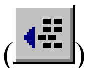
Figure 6-9: ESM editor.

ESM receiver polarization

Polarization is the orientation of the antenna's electric field, which may be parallel to the earth's surface (horizontal), or perpendicular to the earth's surface (vertical). The polarization may also be elliptical or circular. Elliptical polarization is the combination of two linearly polarized waves of the same frequency, traveling in the same direction, which are perpendicular to each other. The relative amplitude and phase relationships between the two may be of any value. If the two wave amplitudes are equal and they are 90 degrees out of phase, the polarization is circular.

ESM receiver frequency band table

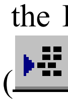
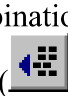
Frequency is the rate of recurrence of an event in periodic motion. The frequency is defined as the speed of light propagating through the atmosphere, divided by the wavelength of the transmitted energy. For an ESM receiver, the entries are the upper and lower frequencies associated with a particular receiver band.

You may enter as may band frequency and sensitivity combinations as you wish. To add more combinations to the table when it appears full, either press the Enter key when the input cursor is on the last entry field or click the Insert Row () toolbar button. To remove a combination, put the input cursor on the row you want to remove and click the Remove Row () toolbar button.

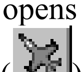
The recommended limits for all frequencies are 100 to 20000 MHz. The units may be MHz or GHz. While the parabolic equation technique of APM is capable of higher frequencies, we have set a hard upper limit of frequency to 57 GHz. This is because APM has only implemented the gaseous absorption model up to that frequency.

ESM receiver sensitivity band table

The measured or specified receiver sensitivity in decibels above a milliWatt (dBm) for each receiver band. Sensitivity values are normally negative. A typical good ESM sensitivity for microwave frequencies is -80 dBm.

You may enter as may band frequency and sensitivity combinations as you wish. To add more combinations to the table when it appears full, either press the Enter key when the input cursor is on the last entry field or click the Insert Row () toolbar button. To remove a combination, put the input cursor on the row you want to remove and click the Remove Row () toolbar button.

Target Editor

The target editor, figure 6-10, opens by selecting **New Target** from the **System** menu, or by clicking the target editor () toolbar button. To open an existing target, select the Open/Remove Target item from the System menu. When the selection window opens, double click on the name or click the Open button. To remove a target, highlight those you intend to remove and click the Remove button. If more than one target is highlighted, you will receive a confirmation notice. Refer to navigating the AREPS windows for a general discussion of data input, editing, etc.

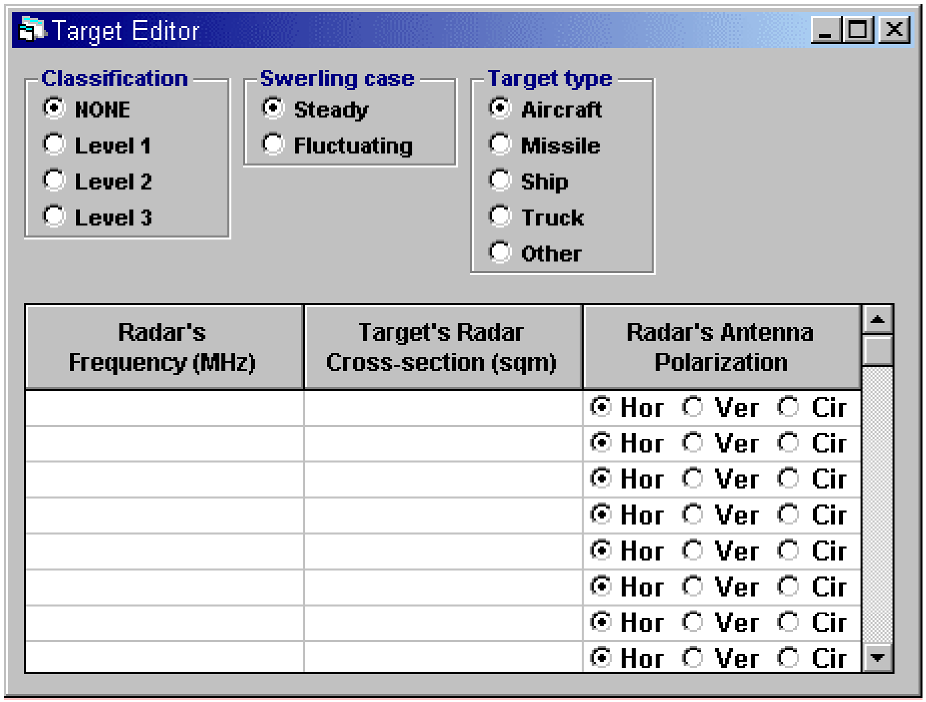


Figure 6-10: Target editor.

Swerling Case

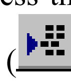
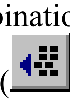
Most real targets exhibit fluctuations in the radar cross-section. These fluctuations must be considered when computing the signal-to-noise ratio. In 1960, Swerling proposed four models for these fluctuations in radar cross-section. His cases 1 and 2 apply to a complex target consisting of many independent scattering surfaces, all of which are approximately the same size. His cases 3 and 4 apply to a target that consists of one large reflecting surface with other small reflectors. For AREPS, only steady and Swerling Case 1 targets are considered. For Swerling Case 1, the fluctuation is negligible from pulse to pulse and uncorrelated from scan to scan. Case 1 may be typical of aircraft while steady may be appropriate for ships. These selections will provide the most conservative value and will not produce an unreasonably high signal-to-noise ratio.

Target Type

Select a target type by clicking on one of the option buttons. For AREPS 3.0, this target type is just a description used for labeling. Future versions of AREPS will expand the functionality of the target type designation.

Target frequency table

Frequency is the rate of recurrence of an event in periodic motion. The frequency is defined as the speed of light propagating through the atmosphere, divided by the wavelength of the transmitted energy. For a target, it is the frequency of the radar corresponding to the measured radar cross section for a particular target.

You may enter as may frequency, cross-section, and polarization combinations as you wish. To add more combinations to the table when it appears full, either press the Enter key when the input cursor is on the last entry field or click the Insert Row () toolbar button. To remove a combination, put the input cursor on the row you want to remove and click the Remove Row () toolbar button.

When the project executes, the frequency of the radar selected is used to enter the target frequency table. If a frequency is found, the radar's polarization will be compared to the polarization in the polarization table. If a match is found, the corresponding cross-section will be used in the calculations. If there is a frequency match but no polarization match, the cross-section associated with the frequency will be used. If no match in frequency is found, the cross-section associated with the closest frequency will be use. AREPS does not perform any cross-section averaging or other interpolation schemes to determine the radar cross-section.

The recommended limits for all frequencies are 100 to 20000 MHz. The units may be MHz or GHz. While the parabolic equation technique of APM is capable of higher frequencies, we have set a hard upper limit of frequency to 57 GHz. This is because APM has only implemented the gaseous absorption model up to that frequency.

Target radar cross-section table

A target's radar cross section is a term used to describe the signal scattering efficiency of the target. It is a function of the target's shape, the materials it is made of, the angle at which it is viewed (which implies a range dependency), the radar frequency, and the polarization of the transmitting and receiving antennas. The units of radar cross section are units of area. In early work, the common unit was the square foot, but currently the accepted unit is square meter. It also may be expressed in decibels relative to the standard. Thus, a target's radar cross section may be expressed in decibels relative to 1 square meter.

The most direct way to determine the radar cross section is to illuminate the target, or a scale model of it, with a well calibrated radar and measure the return signal. Other ways are by direct solution of Maxwell's equations for the boundary conditions appropriate to the object (usually impossible for all but the simplest shapes) or by some approximation technique based upon EM theory. Because the radar cross section is a function of so many variables, it should never be extrapolated, inferred, or "guessed" from the cross section of another target.

For AREPS, you must specify the radar cross section directly in addition to the associated frequency and polarization of the radar being used. You may enter as may frequency, cross-section, and polarization combinations as you wish. To add more combinations to the table when it appears full, either press the Enter key when the input cursor is on the last entry field or click the Insert Row () toolbar button. To remove a combination, put the input cursor on the row you want to remove and click the Remove Row () toolbar button.

For the purposes of AREPS, targets specified in this target window are considered point source targets with a single cross section.

A ship is considered a distributed target because it has some many reflecting surfaces. In order to approximate it as a point source target, the radar cross section (σ) may be approximated by

$$\sigma = 52 f^{0.5} D^{1.5}$$

where f is the frequency in MHz and D is the ship's full load displacement in kilotons. In order to make the assumption of a point source target for a surface ship, the ship must be at a far range.

The radar cross-section of a ship target used in the surface-search range table decision aid is not that as specified in this target window. For surface targets within the surface-search range table decision aid, the radar cross-section is an integration of cross-sections over height and azimuth. These distributed cross-sections must be entered by technical support within the AREPS source code itself. A future version of AREPS may allow a user to construct his own surface target.

OPTIONS

AREPS uses many global (used universally throughout the program) options that you have control over. These options are selected or specified from the various **Options** menu items, figure 7-1.

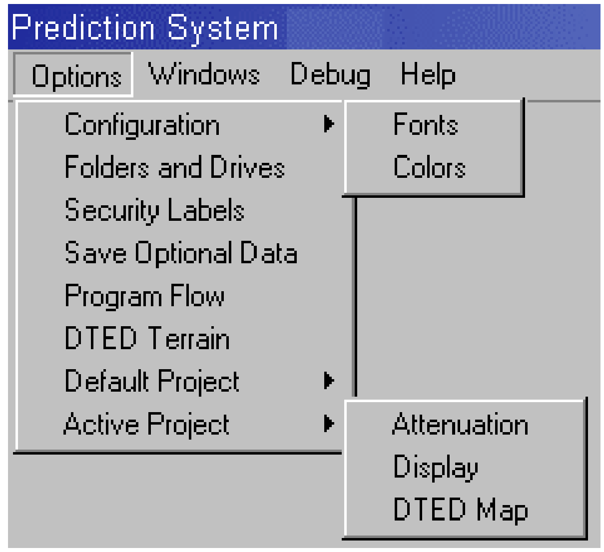


Figure 7-1: Options menu.

To allow for greater user flexibility, AREPS makes a distinction between the default values for all projects in general and those values for the currently active project. The currently active project is one for which its window is open and its controls have the current focus. Another way to say this is that an active project window is one who's title bar is shown with the Windows® highlight color.

This distinction allows you to set options that will apply to all new projects as they are created or to change the options for one particular project without having the change affect other projects. To set generalized project options, select the Default Project item from the Options menu. To set or change an individual project's options, select the Active Project item from the Options menu. AREPS will automatically recognize the active project just in case you have more than one project window opened at the same time.

Command Buttons

Across the bottom of the various options windows are command buttons which control how the options are applied. Not all option windows will have the same set of command buttons, depending upon how the option window is used. For example, the Folders and Drives options window is also used for the AREPS initialization window. Regardless of the option window however, a button with the same text will behave the same for each option window.

Continue

Click this button to accept all the option changes you have made and continue with the program. Any option changes you have are written into the AREPS initialization file so they may be active the next time you start the AREPS program.

Quit

Click this button to end the AREPS initialization and stop the program.

Browse

If your current input point is a folder selection, click this button to open a folder browse window from which you can choose a folder.

Apply

With an active project, when the Apply command button is clicked, the changes are immediately reflected in the project. With a default project, when the Apply command button is clicked, the changes will be reflected in any subsequently created project.

Save

With an active project, when the Save command button is clicked, the changes are saved in the project's initialization file. With a default project, when the Save command button is clicked, the changes are saved in the AREPS initialization file.

Cancel

Click this button to ignore all options changes and return to the main AREPS menu.

Help

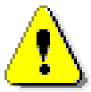
Click this button to receive detailed help for the options.

Configuration Menu

Fonts

As AREPS windows are opened, they are scaled to your screen display settings. While AREPS uses Arial 9 point bold font, it may appear differently on different machines because of the appearance settings (text) in your display properties (refer to your Windows manuals additional information). Should the AREPS windows appear incorrectly, you might use the Fonts window, figure 7-2, to choose another font. Each new window opened will use this newly selected font.

The font window will contain all the fonts currently installed on you computer. By choosing one, you may see what the font looks like. You may change the font size from the dropdown menu and font characteristics such as bold or italic by selecting an option button. Options not available to you because your installed fonts do not support them will have their text shown in red. While we have limited the font size dropdown menu to the smaller fonts, you may type any size directly into the dropdown menu.



You are free to choose any font that you have installed on your computer. This freedom however, may cause two problems. First, when the AREPS window is resized with your new font, it is limited to the physical dimensions of your monitor. Therefore, selecting a large font (say anything over 14 points) may make the window to big to display and you will not see all the input points. If this happens, reduce the point size of your font. Secondly, selecting a font such as Symbols or Klingon will cause the AREPS window (including the font window) to become unreadable.

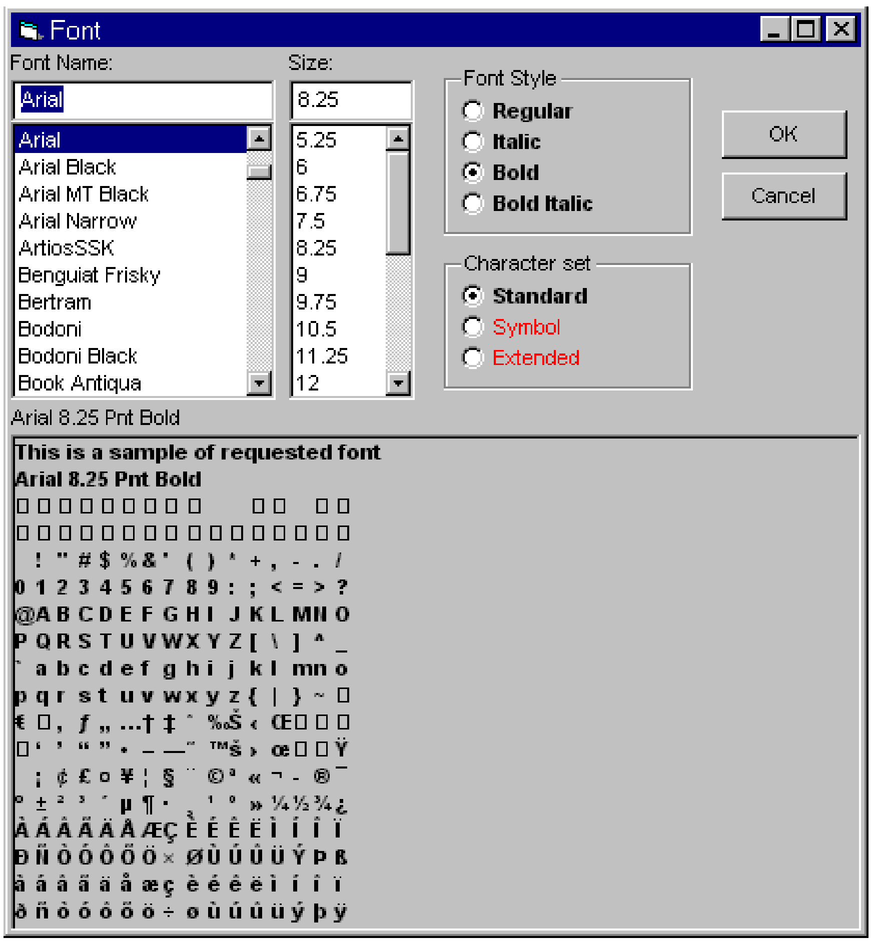


Figure 7-2: Fonts window.

Colors

AREPS uses many different colors for any different purposes. It is our intention to allow you to change any color you wish. However, changing universal colors is not fully implemented from this first version of AREPS 3.0. You may use the Project display item on the Options menu to change the colors for the height versus range coverage display.

The environment program also contains a menu item called Colors, which does allow you to change colors universally for that program.

When you want to change colors, the change colors window, figure 7-3, opens in a compact form showing you little color boxes. To select a new color, simply click on the color box you want and then click the OK button. If the color you want is not shown in the little boxes, click the Define custom colors button. The window will expand showing you a rainbow colored box. Click and drag the mouse over the rainbow of colors. As you do, your current color will show in the box labeled Color|Solid. When you have the color you want, click the OK button.

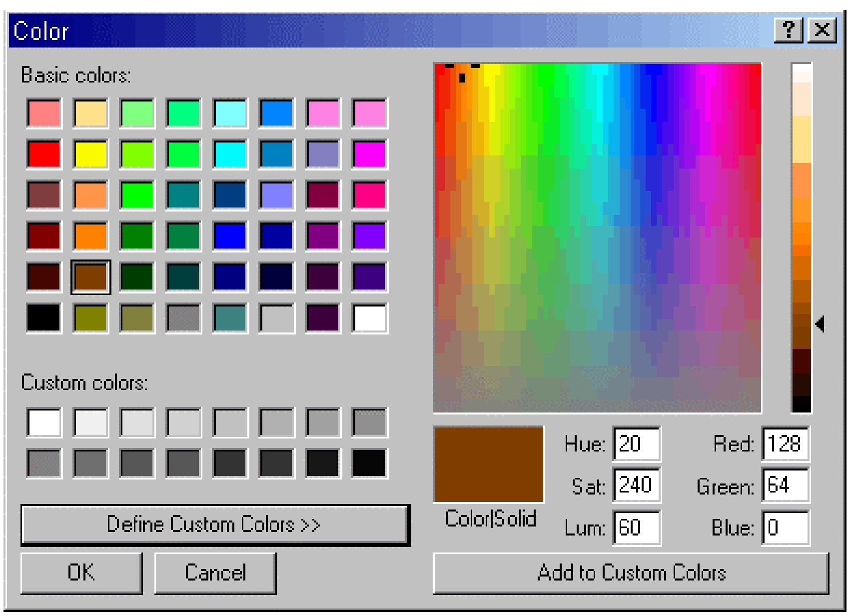


Figure 7-3: Change colors window.

Folders and Drives

AREPS is structured such that it uses a number of folders following the folder conventions of the Common Operating Environment (COE). The paths to these folders are established when you run the program setup. If you installed AREPS as non-COE, you may change the paths to some of these folders after the setup from the Folders and Drive item on the Options menu. By default (for non-COE installations), the AREPS main folder is placed under the Program Files folder as illustrated in figure 7-4. Under the main folder are 2 subfolders, bin, and data.

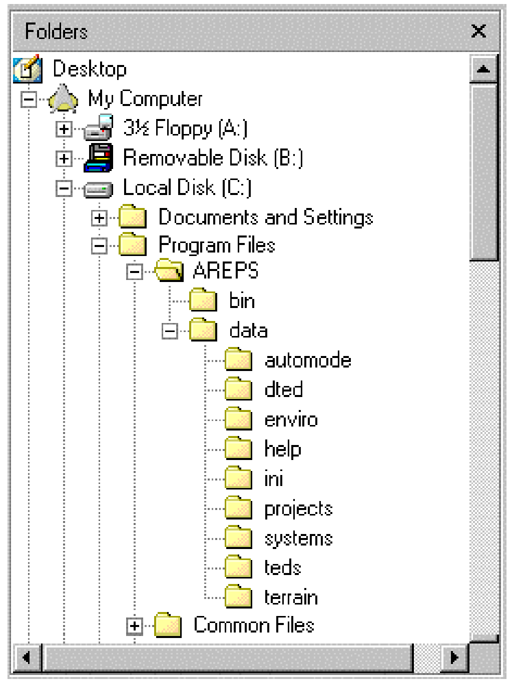


Figure 7-4: AREPS folder structure.

The bin folder contains the program's dynamic link library (.dll) files, and any other supporting executable and multimedia files. The path to the bin folder can not be changed.

The data folder contains a number of subfolders. These are automode, dted, enviro, help, ini, projects, system, teds, terrain, and wind. The data folder and its subfolder paths may not be changed if AREPS is installed as DII-COE compliant.

Using the folders and drives window, figure 7-5, you may change the folder or drive by entering a new path in the input field. If you are unsure of the path, you may click on the Browse button to open a change folder window allowing you to navigate through your system's folder and drive structure.

You may use the Universal Naming Convention to access any folder you have authorization to use. If the folder is on a network drive, you must insure you have access privileges. Your system administrator can help you with privileges. As an example, the terrain folder in the picture below shows a network shared resource.
In addition to the AREPS folder structure, AREPS is capable of interfacing to a number of other programs. If you have any of these programs installed, you may check the appropriate box and provide the folder information necessary.

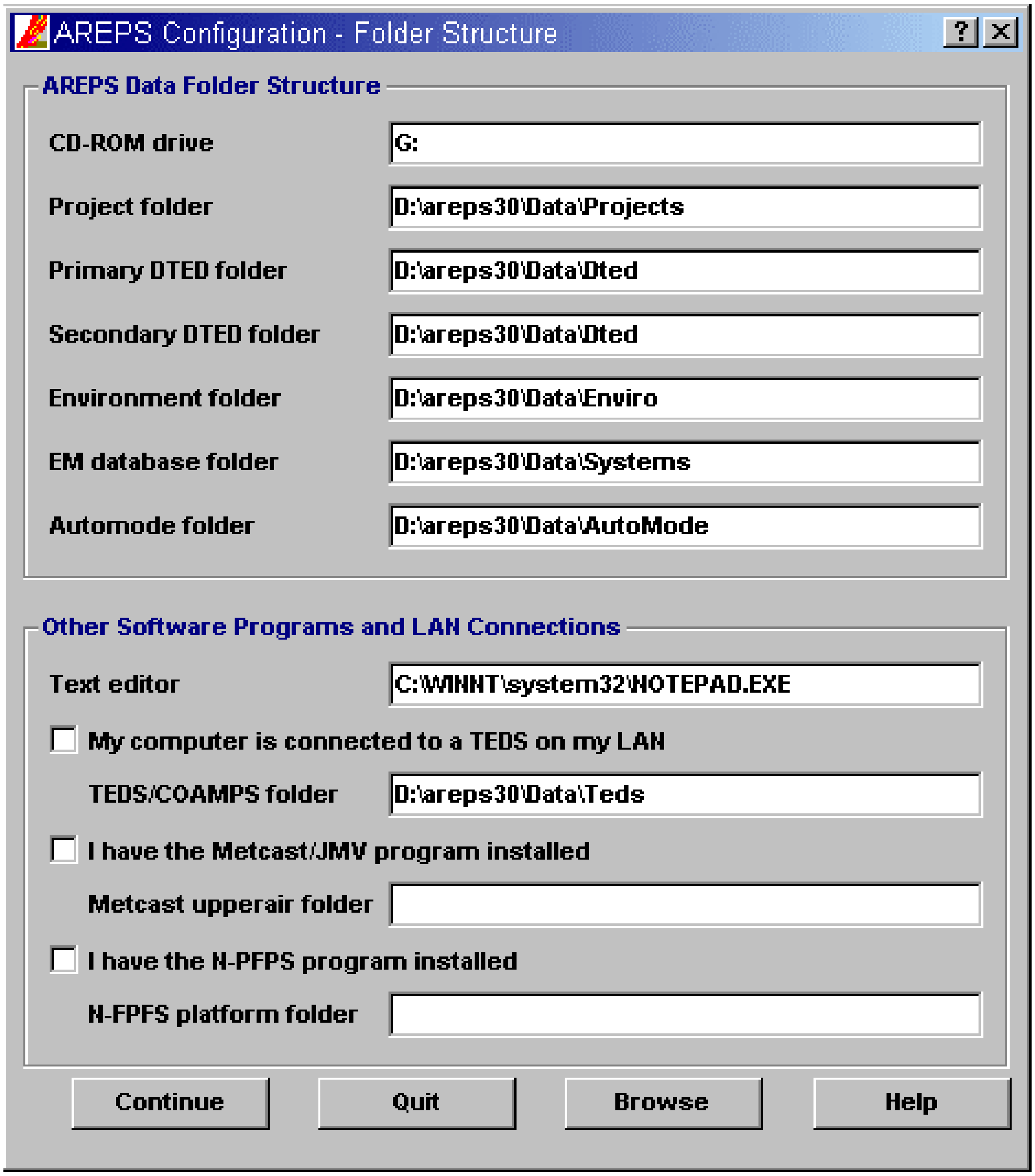


Figure 7-5: Folders and drives options.

CD-ROM drive

The letter of your CD-ROM drive. As you install new hardware drives, the letter of your CD-ROM may change. You may update your CD-ROM drive letter by entering a new value.

The only use of the CD-ROM is for a source of DTED data. While a CD-ROM drive is the default, you may also use this input box to specify a DTED source other than the CD-ROM drive. For example, you may use a shared folder on a network drive. You do this by entering the Universal Naming Convention path rather than the CD-ROM drive letter. You may also use the browse command button to help locate an asset.

Projects folder

As you create projects, they are saved under this folder. By default, this folder is called Projects and is a subfolder of the AREPS data folder. Each project will become its own subfolder of the project folder and will contain all the files (except for DTED terrain data) necessary for executing the project. To change the path to the project folder, enter a new value or choose one using the browse command button.

As each project bearing is executed, a binary file of APM propagation loss data is created. In addition, there may be many optional data files depending upon your selection. As more files are created, the disk space required for a project could become very large. Before each project is executed, the disk space is checked and if it is insufficient, you will receive a warning notice. At this point you may want to change your save options or delete some of the existing files.

Primary DTED terrain folder

This is the path to your DTED terrain folder. You may change it by entering a new path or selecting a new path using the browse command button. Because hard disk access is usually much faster than CD-ROM disk access, as AREPS reads the terrain data from the DTED CD's, the data are optionally written (by default) to this folder for later use. Of course, this folder will grow in size as more data are required. You may use the Universal Naming Convention to access the DTED terrain folder on a network-shared resource.

You are cautioned to watch the amount of disk space available, as low disk space will not only affect the AREPS program but all of your other programs. If time is not a concern, you may want to delete the files within the folder every so often and let AREPS reread the data as required. If free hard disk space is always a problem for you, you may choose to have AREPS read directly from the CD's without copying the data to the hard disk. To do this, select the Terrain item from the Options menu.

You may choose to create your own terrain file (or edit a DTED terrain file) in the custom terrain window. It the file is created in this fashion, the file will be saved in this DTED terrain folder.

Secondary DTED terrain folder

There are a number of programs that use DTED data. To take advantage of any DTED data you may have available, AREPS recognizes two DTED folders. We have designated these folders as primary and secondary. By default, the primary folder is that used by AREPS. The second is that defined by any of your other applications that use DTED data. Enter the application's DTED folder here. You may use the browse command button to help locate a folder.

When AREPS needs DTED data, it will first look in the primary folder. If the data are not found, it will then look in the secondary folder. If the data are still not found, it will look at the CD-ROM. When no data are found in any location, the program will open its terrain manager window and ask you for the necessary DTED CD-ROM.

Environments folder

All the refractivity profiles you create through the environment window are kept in this folder. Your original WMO message data may be located on any disk or in any folder however, including a network drive or folder. To change the path to your environment files, enter a new value or choose one using the browse command button.
EM database folder

By default, the EM system database resides in the AREPS data/systems folder. You may choose however, to have your database elsewhere. For example, for security reasons, you may want your database to reside on a floppy diskette or a removable hard disk so you may store your database in a secure location when it is not being used. To change the database location, enter a new value or choose one using the browse command button.

Automode folder

Automode is an automatic product generator designed for your convenience in providing AREPS support to other people, or for you in producing the same series of decision aids on a routine basis. The automode menus you create are saved in this folder. To change the folder, enter a new name or choose one using the browse command button.

Text editor

There are occasions where AREPS will offer you the opportunity to edit a data file. All AREPS data files (with the exception of the APM binary pathloss files and the DTED terrain files) are ASCII text. As a convenience, AREPS will recognize the text-processing program you have designated for general text processing. If you have not chosen a text editor program for Windows, you may enter the program's path and name in this input field. Doing so will only tell AREPS which program to use. You must make a file association for Windows for programs other than AREPS.

My computer is connected to a TEDS

The Tactical Environmental Data Server (TEDS) is the meteorological and oceanographic (METOC) database component of the Tactical Environmental Support System Next Century (TESS/NC). This database resides on DII-COE database server. TESS (NC) is divided into 5 seamless software versions based upon functionality. The first version is called NITES I and is the local data fusion center and principle METOC analysis and forecast system. NITES version II, a collection of tactical application software packages such as AREPS, is a subsystem on the GCCS (Global Command and Control System) system. NITES I hosts the communications between the database and the NITES II tactical applications. The sharing of the database is accomplished over a network, INTERNET, or SIPRNET, using the ANSI-standard Structured Query Language (SQL).

In order to access the TEDS from AREPS, you must:

1. Be connected via a Local Area Network (LAN) to a NITES I host.

2. Be using an IBM-compatible Personal Computer with a minimum of Windows NT 4.0 service pack 3.

3. Have the DII COE Informix Connect Segment properly installed.

4. Have the DII COE Latitude-Longitude-Time (LLT) Observation API (MALLT) segment properly installed. (AREPS will do this for you during its installation).

If you meet the requirements 1 through 4 above, you may specify that TEDS access is present by checking the TEDS check box. AREPS provides a default TEDS folder which you should accept.

I have the Metcast/JMV program installed

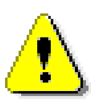
Located in Monterey, California, the U.S. Navy's Fleet Numerical Meteorology and Oceanography Center (FNMOC) provides atmospheric and oceanographic support for the U.S. Department of Defense and other U.S. government agencies at all points on the globe. One of FNMOC's support software packages is the Metcast Data Browser, a powerful, easy-to-use tool for distributing weather and oceanographic information over the Internet using Hyper-Text Transfer Protocol (HTTP) and Multipurpose Internet Main Extensions (MIME), and the Joint METOC Viewer (JMV) displaying and annotating package. AREPS is configured to accept the radiosonde observations obtained via the Metcast. AREPS will be updated in a service package for any changes in the version of the Metcast/JMV.

Prior to using the radiosonde data obtained via the Metcast/JMV in AREPS, the Metcast/JMV software must be downloaded, installed, tested, and if necessary, configured for a specific operating system or browser. If you are an U.S. DoD or other authorized government METOC user, you may contact the FNMOC webmaster at www.fnmoc.navy.mil to establish an account. Once the account is established, a username and password will be issued to you and you may return to FNMOC's homepage to obtain the software and receive additional installation information.

By default, AREPS will assume Metcast/JMV is not installed. If you do have the Metcast/JMV installed, you must enter the Metcast/JMV upperair folder, a special folder for the storage of radiosonde observations. The default folder for Metcast/JMV is c:\jmvwin\moddsfs\upperair. However, you may have assigned a different folder. Unless you specify an upperair folder, this environmental input method will not be available to you. Should you uninstall the JMV or move its location once the environment initialization file is created, simply change the folder location here

I have the N-PFPS program installed

The Naval Portable Flight Planning Software (N-PFPS) package provides the capability for flight mission planning. One component of N-PFPS is FalconView, a mapping package for the PC, which displays various types of maps and geo-referenced overlays. AREPS is able to display its output upon a FalconView background.



In order to use a FalconView overlay, the FalconView program should already be running. If FalconView is not running and you are using Windows 2000, AREPS will start it first and then draw to it. If you are not using Windows 2000, the call to initialize the overlay may cause your system to become unstable producing unpredictable results. We strongly suggest you start the FalconView program before using an overlay.

One flight planning consideration is the pilot’s vulnerability to detection by radar. This of course is one aspect of AREPS’ assessment. There are a number of overlay files used by N-PFPS. The one of concern for AREPS is the FalconView platform overlay file (*.thr). The Platform overlay file contains information for both the Platform itself (its name, its location, and time), and the associated radar (its name, its antenna height, and other information). Enter the folder which contains the N-PFPS platform files. You may use the browse command button to help locate a folder.

Because N-PFPS uses DTED data itself, AREPS recognizes two DTED folders. We have designated these folders as primary and secondary. By default, the primary folder is that used by AREPS. The second may be that defined by the N-PFPS program folder structure. When AREPS needs DTED data, it will first look in the primary folder. If the data are not found, it will then look in the secondary folder. If the data are still not found, it will look at the CD-ROM. When no data are found in any location, the program will open its terrain manager window and ask you for the necessary DTED CD-ROM.

Security Labels

AREPS allows you to label your data with four different classification labels, figure 7-6. Label 0 is predefined as None. You may change the text for any label. For example, label 1 may be my eyes only. To change the text for a security label, enter a new value.

It is your sole responsibility to adhere to the data security requirements dictated by higher authorities. This utility is strictly a convenience-labeling feature and as such, the AREPS developers assume no responsibility for unauthorized release of classified data or misuse of this feature.

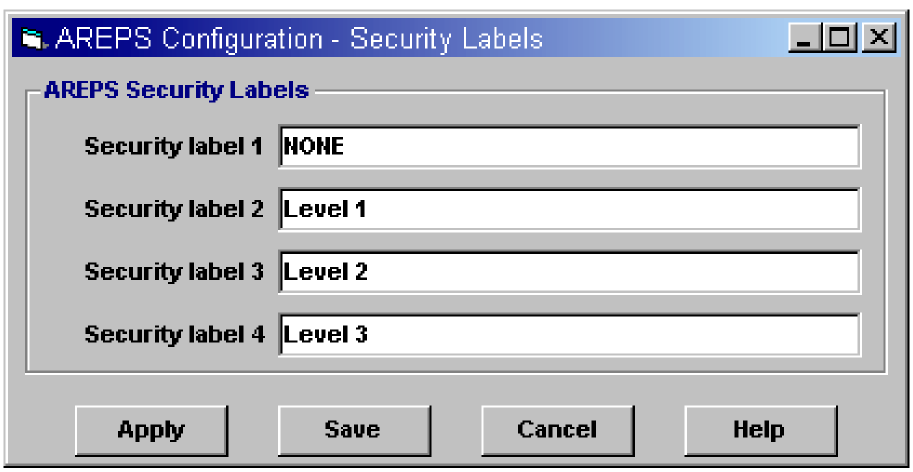


Figure 7-6: Security labels.

Save optional data

AREPS allows you to save data in a number of formats in addition to simply

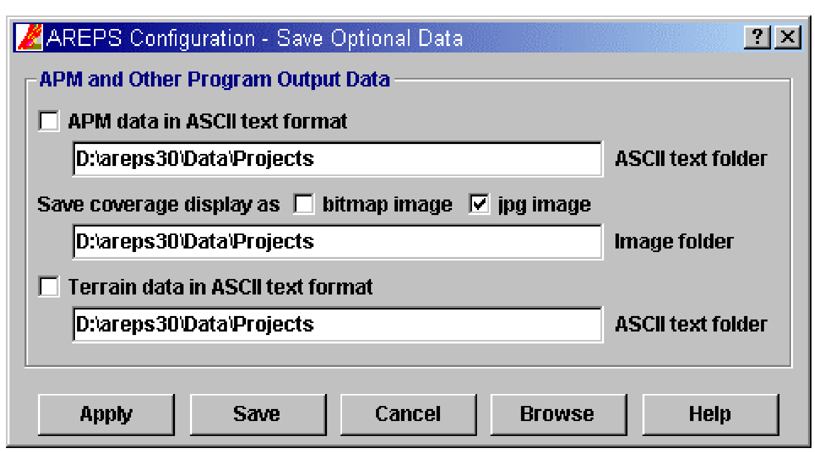


Figure 7-7: Save optional data.

displaying the decision aid. These data may then be used in your own research or in any other manner you choose. These options, illustrated in figure 7-7, allow you to specify the type and name of the file to save.

APM data in ASCII text format

You may desire access to the propagation loss versus height and range data for use in your own evaluation program. Since many programs such as Microsoft Excel or The Math Works, Inc. MATLAB allow for import of ASCII text data, you may choose to have these data saved in an ASCII text file format.

By default, the folder in which these files are saved is the project folder. You may choose a different folder by entering its name here or selecting one from the Browse command button. The file name is ProjectName_Apm_ddd_mm_ss.bmp where the ddd represents the bearing degrees, mm the bearing minutes, and ss the bearing seconds.

The file contains header information to completely describe the project and all other data used to compute the propagation loss. Each section of data is preceded by a section name enclosed in square brackets, for example [Terrain]. Under each section are the data in the format of data name, an equal sign, the data value, and a comment preceded by the pound sign (#).

For the [Pathloss] section, the first line of data is the range for each APM calculation step. Usually there are 440 range steps. Each succeeding line contains the pathloss data in centibels with the height being the first number in the line. Usually there are 384 lines. Each line of data is terminated with a carriage return and line feed character. An example of such a file is:

```
[Apm Information]
ApmVersion         = "1.03.00.00"
ApmVersionDate     = "12/07/1999"
Comment            = "
LibVersion         = "3.00.01.02"
LibVersionDate     = "10/01/2001"
PathName           = "

[Apm System]
AbsHum       = "0"      # Abs Humidity(g/m3)
AntGain      = "39"     # Antenna gain in dB
AntHt        = "22.86"  # Antenna ht(m) above ground
Bwidth       = "1.5"    # Vertical beam width in degrees
Clutter      = "0"      # Clutter calculations (0-No 1-Yes)
Elev         = "0.5"    # Elev angle(deg)
Extrapolate  = "0"      # Extrapolate flag
Freq         = "3000"   # Frequency(MHz)
Gammaa       = "0"      # Gas absorb(dB/Km)
```

```
Gammac         = "0"
Hmax           = "10000"  # Maximum height Meters
Hmin           = "0"      # Minimum height Meters
HorBw          = "0"      # Horizontal beamwidth in deg
Igr            = "0"      # Number of Rgrnd() types
Ipat           = "5"      # Antenna pattern type
Ipol           = "1"      # Polarization 0-Horz,1-Vert,2-Circ
Itp            = "101"    # Terrain points
Itropo         = "0"      # Troposcatter [0 No, 1 Yes]
Iw             = "0"      # Number of wind speeds and ranges
Lerr12         = "0"      # Error flag
Lerr6          = "0"      # Error flag
Lvlp           = "2"      # Number levels in refrac profile
Nfacs          = "2"      # Number of cut-back angles
Nprof          = "1"      # Number ranges in refrac profile
Nrout          = "440"    # Range steps to output
Nzout          = "384"    # Ht points to output
PulseWidth     = "9"      # Pulse width/length in usec
Rmax           = "185200" # Maximum range Meters
SysLoss        = "3"      # System losses in dB
Tair           = "0"      # Air Temp (C)
TransPower     = "2000"   # Transmitter power in KW
WindDir        = "0"      # Wind direction in mps

[Antenna factors]
# 2 Antenna pattern factors:  Angle, Factor
AntPatFac(0)  = "2", ".9"
AntPatFac(1)  = "4", ".7"

[Ground data]
#   2   GroundData   :   Type,     Range(km),   Permittivity,
Conductivity
Ground(0)     =  "Fresh water", "24.7", "0", "0"
Ground(1)     =  "Medium dry", "34.4", "0", "0"

[Profiles]
# 1 Profiles: Range in meters
ProfileRange(0)   = "0"                # Range for level 0

#    2 Levels of data(L,P):  Ht(m), Munits
ProfileData(0, 0) = "0", "0"
ProfileData(1, 0) = "12192", "1440"
#
[Terrain]
# 101 Terrain points : Range(Km) Ht(m)
Terrain(0)        = "0", "0"
Terrain(1)        = "1852", "0"
```

```
Terrain(2)        = "3704", "0"
Terrain(3)        = "5556", "0"
Terrain(4)        = "7408", "0"
Terrain(5)        = "9260", "0"
Terrain(6)        = "11112", "0"
Terrain(7)        = "12964", "0"
Terrain(8)        = "14816", "0"
Terrain(9)        = "16668", "200"
Terrain(10)       = "18520", "272.2"
Terrain(11)       = "20372", "320"
Terrain(12)       = "22224", "300.0612"
Terrain(13)       = "24076", "202.3839"
Terrain(14)       = "25928", "286.9567"
Terrain(15)       = "27780", "340"
Terrain(16)       = "29632", "469.3772"
Terrain(17)       = "31484", "400"
...

[Wind]
# 2 Wind elements:  Range(Km) WindSpeed(m/s)
Wind(0)  = "0", "10"
Wind(1)  = "20", "9"

[Thresholds]
# Thresholds in DB, Probability of detection and colors for
values <= the threshold.
Threshold(0) = 0,        100.0, 16777215  # 0x00FFFFFF
Threshold(1) = 136.9188,  90.0, 255       # 0x000000FF
Threshold(2) = 138.6142,  80.0, 65535     # 0x0000FFFF
Threshold(3) = 139.6757,  70.0, 16711935  # 0x00FF00FF
Threshold(4) = 140.49,    60.0, 16711680  # 0x00FF0000
Threshold(5) = 141.1839,  50.0, 65280     # 0x0000FF00
Threshold(6) = 141.8213,  40.0, 33023     # 0x000080FF
Threshold(7) = 142.4491,  30.0, 8421376   # 0x00808000
Threshold(8) = 143.1236,  20.0, 32768     # 0x00008000
Threshold(9) = 143.9704,  10.0, 8388608   # 0x00800000
Threshold(10) = 9999,      0.0, 12632256  # 0x00C0C0C0

[Probability of detection]
# Thresholds in DB for a probability of detection from 1%
to 100%
137.48  137.09  136.82  136.61  136.44  …
135.69  135.59  135.50  135.41  135.32  …
134.85  134.78  134.71  134.64  134.57  …
134.18  134.11  134.05  133.99  133.92  …
133.54  133.48  133.42  133.35  133.29  …
132.90  132.83  132.76  132.69  132.62  …
```

```
132.19  132.11  132.03  131.95  131.87  …
131.35  131.25  131.16  131.05  130.95  …
130.24  130.10  129.96  129.81  129.65  …
128.41  128.13  127.82  127.45  127.03  …

[Apm Loss Data]
# 440 range steps from 454.545 to 200000. by 454.545 meters
# 385 heights from 0. to 5000. by 13.021 meters.
# The range of the nTh element (1 to 440) is computed by (n
* 454.545) in meters.
# The height of the nTh element (0 to 384) is computed by
(n * 13.021) in meters.

Height(0) = 0.
    3347    1064    1069    1099    1128    1157    1181 …
    1372    1381    1390    1398    1406    1415    1422 …
    1514    1522    1529    1534    1538    1542    1547 …
     …
Height(1) = 13.021
    940     926     935    1006    1012     982     978 …
   1110    1118    1126    1134    1142    1150    1157 …
   1247    1252    1258    1263    1269    1274    1280 …
   …
```

Coverage display in graphic image format

Prior to AREPS version 3.0, an image of the decision aid was saved in the project’s folder each time the project was executed. This consumed large amounts of hard disk space. AREPS 3.0 no longer requires these images for display. However, you may optionally save them.

By default, the folder in which these files are saved is the project folder. You may choose a different folder by entering its name here or selecting one from the Browse command button. The file name is ProjectName_AREPS_ddd_mm_ss.* where the ddd represents the bearing degrees, mm the bearing minutes, ss the bearing seconds, and the * either bmp for a 16 color bitmap image or jpg for a Joint Photographic Experts Group image.

Terrain data in ASCII text format

You may desire access to the terrain data for use in your own program. Since many programs such as Microsoft Excel or The Math Works, Inc. MATLAB allow for import of ASCII text data, you may choose to have these data saved in an ASCII text file format.

By default, the folder in which these files are saved is the project folder. You may choose a different folder by entering its name here or selecting one from the Browse command button. The file name is ProjectName_Terrain_ddd_mm_ss.bmp where the ddd represents the bearing degrees, mm the bearing minutes, and ss the bearing seconds.

The file format is data name, an equal sign, the data value, and a comment preceded by the pound sign (#). An example of such a file is:

```
[AREPS Custom Terrain]  # Areps30  January 15 2002 12:23:18
PathName="C:\ProgramFiles\AREPS\ProjectName_Terrain_12.txt"
Latitude       = " 32 N"     # Center latitude
Longitude      = "117 W"     # Center longitude
Bearing        = "12"        # Bearing from center
RangeUnits     = "nmi"       # Range units
HeightUnits    = "ft"        # Height units
RangeGrndUnits = "nmi"       # Range units for ground types

TerrainType     = "Sea water" # General terrain type - used
if no ground types specified

Grounds        = "3"          # Number ground types
# Ground Type, Range, Permittivity, Conductivity
Ground(0)      = "Sea water", "0", "0", "0"
Ground(1)      = "Marsh", "10", "0", "0"
Ground(2)      = "Medium sized towns", "40", "0", "0"

Points         = "6"          # Number terrain points

# Range and Heights
Point(0)       = "0", "0"                # Range and Height
Point(1)       = "10", "10"              # Range and Height
Point(2)       = "20", "40"              # Range and Height
Point(3)       = "30", "60"              # Range and Height
Point(4)       = "40", "100"             # Range and Height
Point(5)       = "50", "110"             # Range and Height
```

Remove all optional files

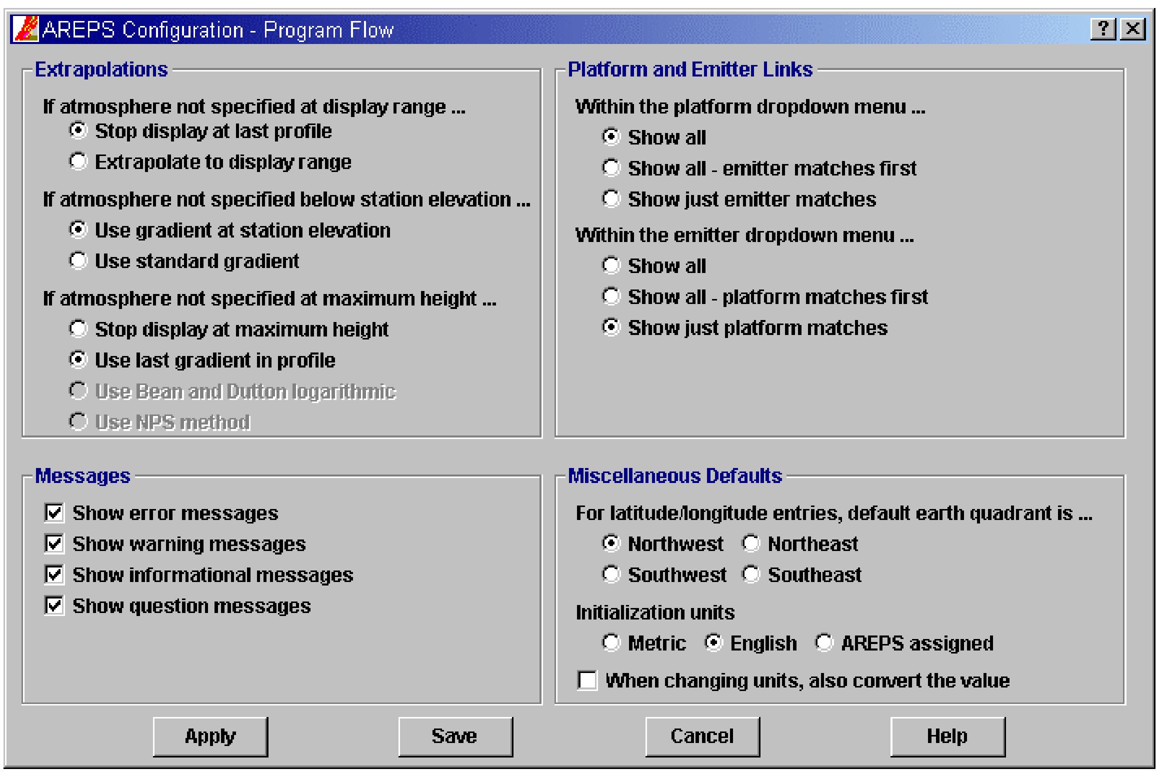
By default, this option is set to true and is used to conserve hard disk space. When AREPS executes a project, many optional files (as specified with the Save optional data item from the Options menu) may be created and placed into the project's folder. An example of such an optional file is the bitmap image of a coverage decision aid.

As an example, you may want a project to save the decision aid images at bearings 000 degrees and 010 degrees so you can use them in a Microsoft PowerPoint presentation. The next time you execute the project, you may want the decision aid images at bearings 180 degrees and 190 degrees. By default, all the optional files from the previous execution are removed, that is, the image files associated with 000 and 010 decision aid are removed.

Removing optional files has no affect on a project's ability to display a previous execution.

Program flow

Many decisions need be made concerning how AREPS handles inadequate environmental data, displays error windows, and presents the EM database. In addition, other miscellaneous program defaults may be specified here. Figure 7-8 illustrates the program flow options.



Extrapolations

If atmosphere not specified at maximum range

For range dependent environments, you should have the environment fully specified to the display range. If it is not, a decision needs to be made about how to proceed. You may have the decision aid stop at the range of the last environment specification or you may have the last specification extrapolated to the display range. In the case of the latter, your environment will be horizontally homogeneous (not range dependent) from the range of the last specified profile to the display range.

If atmosphere not specified below station elevation

You must have your environment specified from the minimum display height to the maximum display height. If the first height specification is above this minimum height, a decision needs to be made about how to proceed. For example, your project's minimum height is 1000 feet below mean sea level as you are evaluating a system in the area of the Dead Sea. The radiosonde station elevation is 730 feet below mean sea level. You may have AREPS extrapolate the environment downward from the first specified height (-730 feet) to the minimum height (-1000 feet) using either a standard atmospheric gradient or using the gradient between the first (WMO surface group - 00XXX) and second height (WMO first significant level group - 11XXX) levels in the specification.

For station elevations above mean sea level and if necessary, the environmental file creation routines will automatically extrapolate the sounding to 0 meters (mean sea level). The extrapolation technique you choose here is used.

If atmosphere not specified at maximum height

You should have the environment fully specified to the maximum display height. If it is not, a decision needs to be made about how to proceed. You may have the decision aid stop at the height of the last environment specification, use the last specification extrapolated to the display height, use the Bean and Dutton logarithmic extrapolation technique to the display height, or use the Naval Postgraduate School's (NPS) radiosonde height extrapolation technique. For AREPS 3.0, the Bean and Dutton and the NPS techniques are not implemented.

Messages

There may be times where you may not want to see the error and message-handling window. By unchecking a particular message type, the window for that message type will not become visible. You may also check the "Don't show…" checkbox within the error and message handling window itself. Even though the window may be turned off, all the other error conventions still function. That is, a critical program error will cause the program to not to perform a function, or a soft limits input violation will still cause the input field background color to turn yellow. For all non-critical messages, the default (affirmative) action will be taken. You may reactive the window by checking the desired window type found on the Program Flow item of the Options menu.

Platform and Emitter links

To help organize your EM systems, AREPS allows you to create platforms containing certain emitters. When you select a platform from the platform dropdown menu on the project form prior to selecting an emitter, the emitter dropdown menu will automatically be filled with the emitters on that platform. However, you may want to assess an emitter that is not on your currently selected platform and, for this case, the desired emitter is not available. From these options, you may choose how you would like AREPS to fill the emitter and platform dropdown menus.

Within The Platform Dropdown Menu…

You may have the emitter dropdown menu filled from just those emitters on the platform. You may fill first from those emitters on the platform (these names will be in capital letters) and then all the remaining emitters in the database (these names will be in small letters). Or, you may ignore the selected platform and fill the dropdown menu with all the emitters in the database.

Within The Emitter Dropdown Menu…

As with the platforms, when you select an emitter before selecting a platform, the platform dropdown menu is filled with those platforms that hold your emitter. However, you may have it filled first with the platforms holding the emitter (these names will be in capital letters) and then all the remaining platforms in the database (these names will be in small letters). Or, you may ignore the selected emitter and fill the dropdown menu with all the platforms in the database.

Miscellaneous Defaults

For Latitude and Longitude Entries

When entering latitude and longitude values, you must also specify a quadrant. This may be W for west, E for east, N for north or S for south. When both lower and upper bounds of an input field are in the same quadrant, AREPS will automatically select the quadrant and enter it for you so you don't have to type it yourself. If the bounds are in different quadrants, you must enter it. If you don't, the default is east longitude and north latitude. For those uses exclusively in the southern or western hemispheres, the default can be an annoyance. Thus, you can choose to have the default hemispheres other than Northeast. Once set, you no longer need to type the quadrant into the field.

Initialization Units

AREPS uses a wide variety of units for its input values. For your application, the AREPS assigned units may not be those you desire. Thus, by using this units initialization option, you may have AREPS set all units to metric, to English, or you may select to use the units as assigned by AREPS.

When Changing Units, Also Convert The Values

Right clicking the mouse cursor on the label for the field may change the units of any input field. For example, the units of frequency may be changed by right clicking on the word "frequency." If values are in a tabular form like the radar cross section of a target, the units may be changed by right clicking on the label at the top of the column. By default, changing units will not affect the number within the input field. By checking this option, all numeric values will be converted to the new units when the units change.

When values are converted, they may be rounded and precision may be lost. Converting the value again could compound the rounding error. Therefore, converting back to the original units may not convert the value back to its original value. USE THE CONVERT UTILITY WITH CARE!

DTED Terrain Options

AREPS allows for many terrain options, selectable from the DTED terrain options as illustrated in figure 7-9.

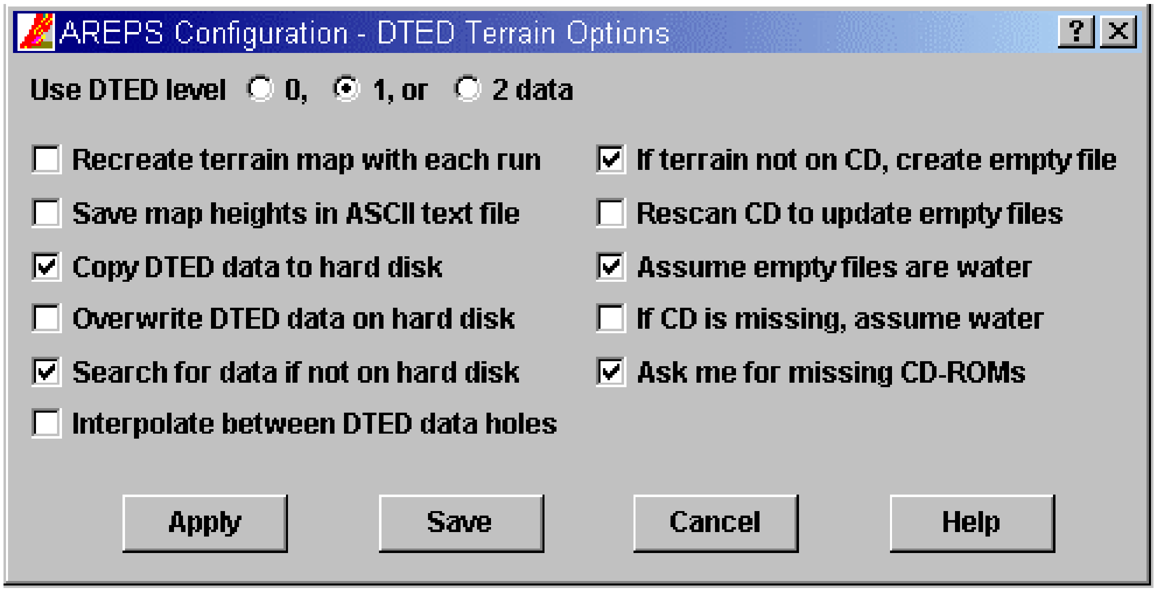


Figure7-9: DTED terrain options.

Use DTED Level …

AREPS, as the default, uses digital terrain elevation data from NIMA. DTED are a uniform matrix of terrain elevation values, providing basic quantitative data for systems that require terrain elevation, slope, and/or gross surface roughness information. DTED data are provided in level 0, level 1, and level 2 formats. Level 0 spacing is 30 arc seconds in horizontal resolution (approximately 1 kilometer). DTED level 0 data are unlimited distribution and may be obtained directly from NIMA's public Internet homepage. Level 1 spacing is 3 arc seconds in horizontal resolution (approximately 100 meters). Level 2 spacing is 1 arc seconds in horizontal resolution (approximately 30 meters). Level 1 and 2 data are limited distribution. For this reason, DTED data are not and may not be distributed with AREPS. If you have a connection to the Secure Internet Protocol Router Network (SIPRNET), you may download the DTED level 1 and 2 data directly from NIMA's SIPRNET homepage. In addition, NIMA provides terrain data in other formats such as raster graphics. However, AREPS 2.0 will currently only accept NIMA's DTED level 0, 1, and 2 coverage.

Recreate Terrain Map with Each Run

When a project is first executed, if you choose to have a terrain map, the map image is created from the data on the DTED CD-ROMs. The image is saved in the project's folder in a temporary graphic bitmap format file with the name *terrain map.bmp*. If the project is re-executed and this image exists, it is shown directly without recreating it from the DTED terrain data. You may, however, have changed the latitude and longitude between the first execution and the next and, thus, the map image will be out of date. You may choose to have the map image recreated every time the project is executed.

Save Map Heights as ASCII Text

When a project is first executed, if you choose to have a terrain map, the map image is created from the data on the DTED CD-ROMs. If you want these data for your own use external to AREPS, you may choose to have these height and range data saved in the project's folder in a temporary ASCII format file. The file name is fixed as *terrain map.dat*. Please understand this may be a very large file.

Copy DTED Data to Hard Disk

Because hard disk access is usually much faster than CD-ROM disk access, the data are written (by default) to the terrain folder for later use, as AREPS reads the terrain data from the DTED CD-ROMs. Of course, this folder will grow in size as more data are required. If free hard disk space is always a problem for you, you may choose to have AREPS read directly from the CDs without copying the data to the hard disk.

You are cautioned to watch the amount of disk space available, as low disk space will not only affect the AREPS program but all your other programs. If time is not a concern, you may want to delete the files within the terrain folder every so often and let AREPS reread the data as required.

Overwrite DTED Data on Hard Disk

When the project requires DTED terrain data, it will first look in the terrain folder before looking elsewhere. If the proper terrain file is found, its data are used. In the course of time, you may obtain updates to the DTED CD-ROMs. If the terrain files are already in the folder, the new CD-ROMs will never be looked at. You may choose to have AREPS read the new CD-ROMs and overwrite the old data with the new.

Search for Data if not on Hard Disk

When the project requires DTED terrain data, it will first look in the terrain folder before looking elsewhere. If the data are found, they are used. If the data are not found, you may choose to have AREPS automatically search the CD-ROM. If the data are found, they are used. If the data are not found, AREPS will assume the terrain heights to be zero.

Interpolate Between DTED Data Holes

While the DTED CD-ROM may contain a terrain file for a particular geographical location, a specific latitude and longitude within the file may have missing height data.

You may choose to have AREPS interpolate between height data present in order to provide a height for the missing location. Please understand interpolation may not necessarily be the correct procedure to provide missing information. As the terrain profile draws on the decision aid, you may examine the data to insure you feel comfortable with the interpolation. In cases where missing data is assumed to be water, heights will be zero, and no interpolation will occur.

If Terrain not on CD, Create Empty File

In some cases, the DTED CD-ROM may not contain a file for a particular geographical location. You may examine the map on the CD-ROM liner notes to see which locations are missing. If the file is missing from the CD, an empty file is written to the terrain folder on your hard disk as a placeholder. The empty file will be filled with heights of zero. Having the empty file present saves AREPS time by not having to look for a file already determined to be missing and also allows AREPS to skip asking you to enter the proper CD-ROM.

Rescan CD to Update Empty Files

The DTED CD-ROM may not contain a file for a particular geographical location. You may examine the map on the CD-ROM liner notes to see which locations are missing. If a missing file is encountered as AREPS is copying the data from the CD-ROM to the hard disk, an empty file is written on the hard disk as a placeholder. The empty file will be filled with heights of zero. In the course of time, you may obtain updates to the DTED CD-ROM and previously missing files may now be present. You may have AREPS reread the CD-ROM to replace the empty placeholder files with files containing actual elevation data.

If CD is Missing, Assume Water

For whatever reason, you may decline to provide the DTED CD-ROM when requested, or you may choose to have AREPS just ignore any DTED data. If the CD-ROM is not provided, an empty file is not created. Since AREPS requires a surface elevation, an elevation of zero is used. You may choose to have AREPS assume this zero elevation means the surface is water. If so, the terrain map will be colored blue at these zero heights. If water is not assumed, the terrain map will be colored black at these zero heights. As the mouse cursor moves over the terrain map, assumed water will show a height of zero and no assumed water will show a "no height data" message in the label area of the decision aid. In cases where the surface is assumed to be water, heights will be zero and no interpolation will occur.

Assume Empty Files are Water

If a terrain file should be on a DTED CD-ROM but for some reason is not, AREPS will write an empty file to the terrain folder on your hard disk as a placeholder. The empty file will be filled with heights of zero. In most cases, if the file is missing from the CD-ROM, it is because the entire file's geographical area is over water. However, this is not always true. You may examine the map on the CD-ROM liner notes to see which missing locations are actually over water. You may choose to have AREPS assume an empty file represents water. If so, the terrain map will be colored blue at these zero heights. If water is not assumed, the terrain map will be colored black at these zero heights. As the mouse cursor moves over the terrain map, assumed water will show a height of zero and no assumed water will show a "no height data" message in the label area of the decision aid. In cases where missing data are assumed to be water, heights will be zero and no interpolation will occur.

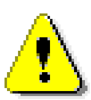
Ask Me for Missing CD-ROMs

If you choose to use DTED terrain data, the project will first look in the terrain folder for the data. If they are not found, it will, optionally, look for a CD-ROM. You may choose not to have AREPS prompt you to enter the required CD-ROMs. You may want to do this if you do not have the CD-ROMs in the first place. If you elect not to be asked, terrain heights will be zero. Refer to the missing CD option for additional information about terrain heights of zero.

Project Attenuations

AREPS considers gaseous absorption in the calculation of propagation loss. Gaseous absorption is due primarily to atmospheric water vapor and oxygen. You may use these options to choose how you would like AREPS to calculate the attenuation as illustrated in figure 7-10.

You may choose not to consider gaseous absorption, to use meteorological observation data within your environmental file (AREPS automatically includes these data if you created your refractive profile from WMO observations), to enter a surface meteorological observation, or you may choose to directly enter a specific attenuation value.



T 57 GHz.

how, or fog. However, ue and use it in place se moisture condition nly in range, which is u

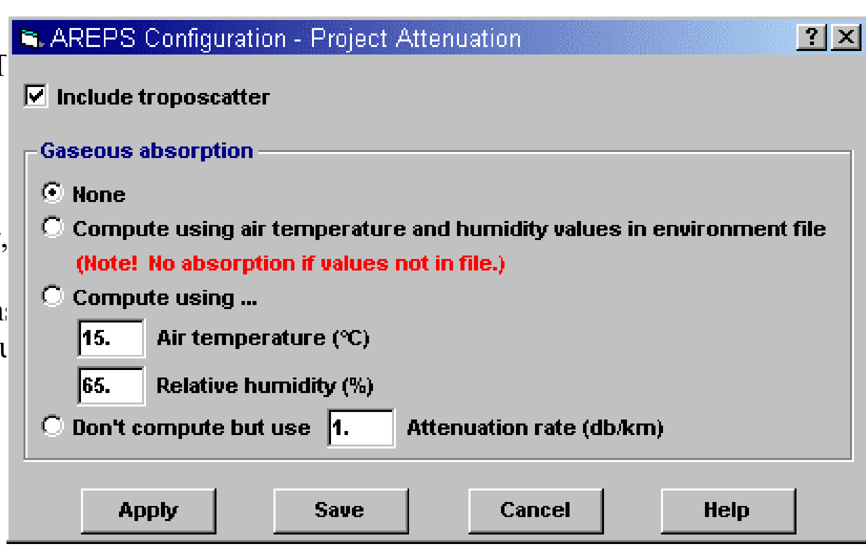


Figure 7-10: Project attenuations.

While not an attenuation mechanism, the option to include troposcatter in the propagation calculations is also found here. Troposcatter is much more important for ESM applications than for radar applications.

Project display

AREPS allows for a number of options in how the graphics, colors, display parameters, etc. are initialized for the project. As an aside, some of these options may also be set directly from a project's display.

If you have opened this window by selecting the Default Project item from the Options menu, by choosing **Save**, these project settings will be saved in the main AREPS initialization file. By choosing **Apply**, these options will remain in effect for all subsequently created projects for the current AREPS session and will revert back to the defaults the next time AREPS is started.

If you have a project window open and active, and you have opened this window by selecting the Active Project item from the Options menu, any changes you make here will be reflected ONLY in the current active project. By choosing the **Save** button, the settings will be save in the project's initialization file. If you choose **Apply**, all changes will be immediately reflected in the current project.

Display parameter

The height versus range coverage display and the display of a quantity versus height/loss may be referenced to probability of detection, propagation loss, propagation factor, or signal-to-noise as illustrated in figure 7-11. Simply click the parameter you desire.

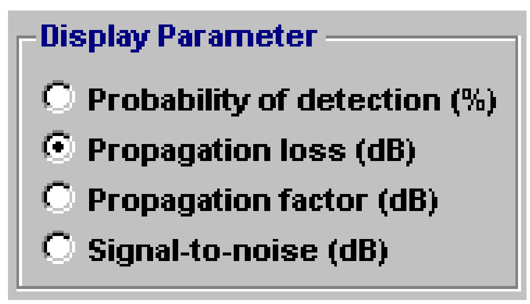


Figure 7-11: Coverage display parameters.

Thresholds and Axis Limits

For the height versus range display, you may specify the limit of this reference, the increment of the reference, and how may increments you want, figure 7-12.

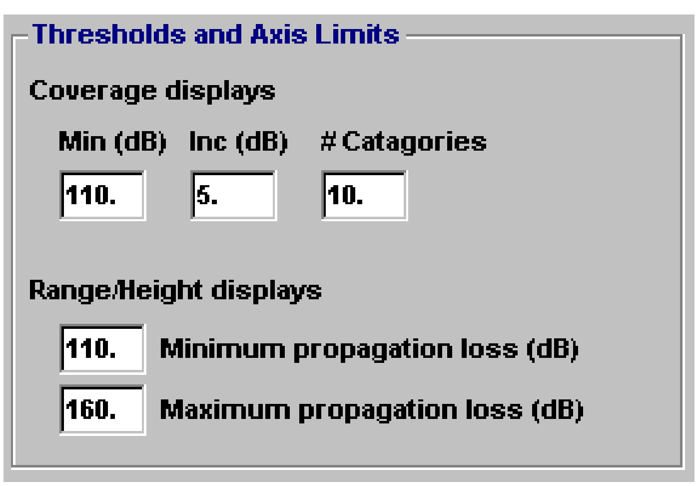


Figure 7-12: Threshold and axis limits.

For example, if you choose propagation loss as your reference. You then may select 110 dB as your minimum propagation loss threshold value, 5 dB intervals, and 9 intervals. On the coverage display, you will see ten boxes on the color bar labeled 0 to 110 dB, 110 to 115 dB, 115 to 120 dB, etc. As another example, you may choose probability of detection as your reference. You may then choose 100% as the limit, 20% as the interval, and 2 intervals. On the display, you will see two boxes on the color bar labeled 1 to .8 and .8 to .6.

For a quantity versus height or range, you may define the minimum and maximum for the axes.

Surface Depiction

Height versus range coverage displays may use one of three different earth presentations, either a flat, curved, or dual curved earth.

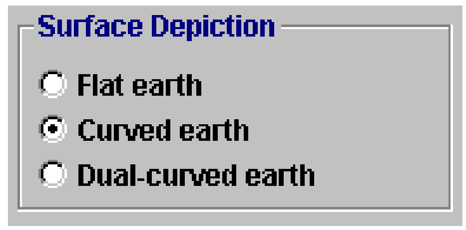


Figure 7-13: Surface depiction option buttons.

You select the surface depiction using the radio buttons, figure 7-13. These depictions are illustrated in figure 7-14. You may also change the surface depiction "on-the-fly" from the decision aid window itself by selecting the depiction from a right click popup menu.

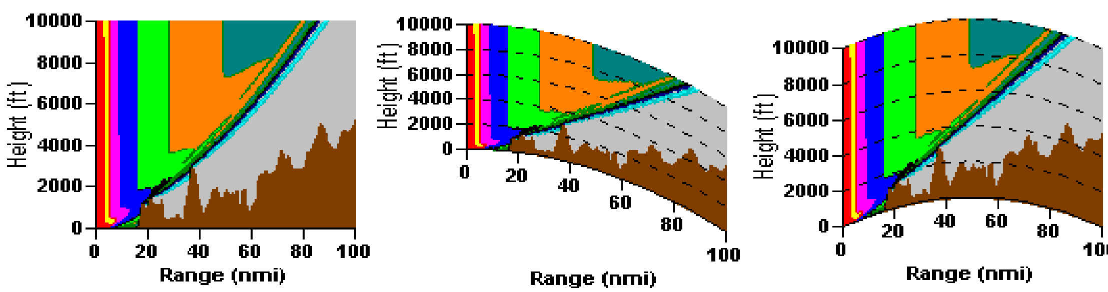


Figure 7-14: Surface depictions.

Miscellaneous display settings

Figure 7-15 illustrates the various miscellaneous display setting options.

For your height versus range display, you may choose to show height, range, and/or angle reference lines. Because the range scale is usually in nautical miles or kilometers and the height scale is usually in feet or meters, the coverage display can have a distortion that is not obvious at first glance. By showing angle reference lines, this distortion becomes apparent. The angle reference lines are drawn for angles of 1, 3, 5, and 10 degrees above the horizontal.

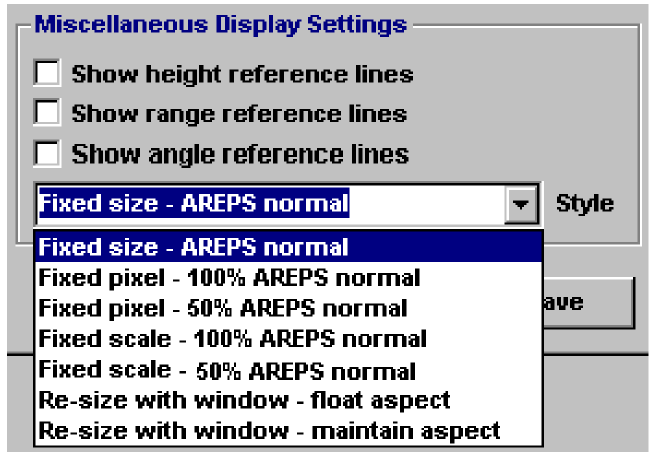


Figure 7-15: Surface depiction option buttons.

There are a number of style settings you can choose for your height versus range coverage display that address the issue of scale distortion when you change the window dimensions. These are:

a. Fixed size – AREPS normal. The coverage display does not change dimensions when you change the window dimensions. If you resize the window smaller than the coverage display, scroll bars will appear on the window so you can still view the entire image.

b. Fixed pixel – 100% AREPS normal. The vertical dimension stays fixed in number of pixels as you change the window dimensions. This means that there is a one-to-one correspondence between the vertical pixels and the APM vertical calculation points. If you resize the window smaller than the coverage display, scroll bars will appear on the window so you can still view the entire image.

c. Fixed pixel – 50% AREPS normal. The vertical dimension stays fixed in number of pixels as you change the window dimensions. The display is 50% of the normal AREPS display. This means that there is a two-to-one correspondence between the vertical pixels and the APM vertical calculation points. In other words, for each vertical pixel, you see every other APM vertical calculation point. If you resize the window smaller than the coverage display, scroll bars will appear on the window so you can still view the entire image.

d. Fixed scale – 100% AREPS normal. The height and range axes remain fixed in dimension and changing the window's dimensions has no effect upon the display. If you resize the window smaller than the coverage display, scroll bars will appear on the window so you can still view the entire image, just not all at once.

e. Fixed scale – 50% AREPS normal. The height and range axes remain fixed in dimension and changing the window's dimensions has no effect upon the display. The size of the display is 50% of the normal AREPS display. If you resize the window smaller than the coverage display, scroll bars will appear on the window so you can still view the entire image.

f. Re-size with window – float aspect. As you change the dimensions of the window the height and range axes independently change dimensions. This could result in great distortion, making the display hard to interpret or misleading upon casual inspection.

g. Re-size with window – maintain aspect. As you change the dimensions of the window the height and range axes change together such that the aspect is properly maintained.

Threshold colors

Each threshold you define is assigned a display color, figure 7-16. These are the colors seen in the legend along the bottom of the height versus range coverage display. You may change any color by right clicking on the color and picking a different one from the color popup window, figure 7-17. If the color you want isn't already showing in the color popup window, you may click the Define Custom Color command button to expand the color selection window for additional colors.

You may also change colors "on-the-fly" from the decision aid window itself, by right clicking on a color in the legend and selecting a color from the color popup window.

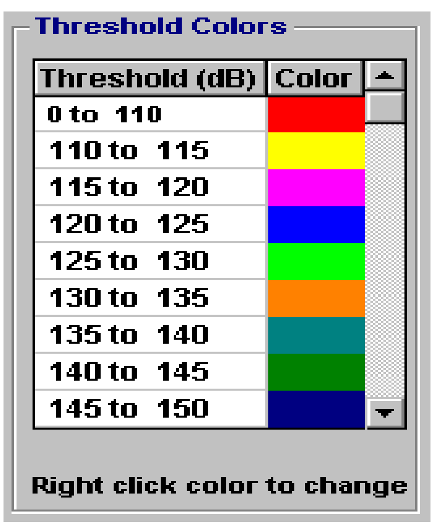


Figure 7-16: Threshold colors.

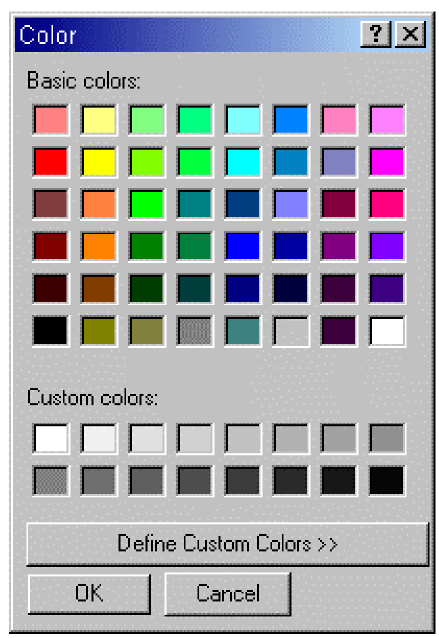


Figure 7-17: Color popup window.

Project DTED map

AREPS allows for a number of

options, figure 7-18, in the consideration and management of the DTED terrain map for the project.

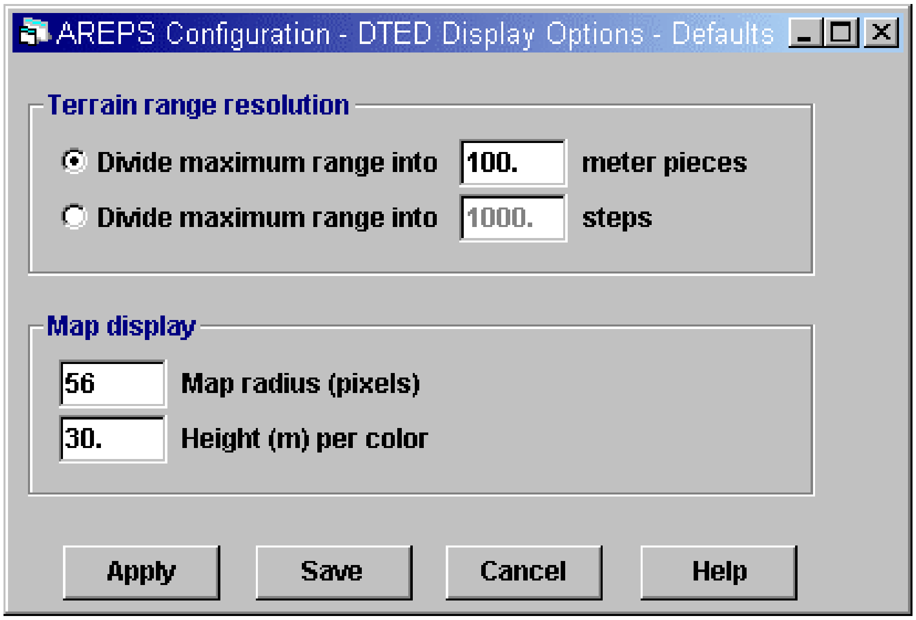


Figure 7-18: Project DTED map options.

If you have opened this window by selecting the Default Project item from the Options menu, by choosing Save, these project settings will be saved in the main AREPS initialization file. By choosing Apply, these options will remain in effect for all subsequently created projects for the current AREPS session and will revert back to the defaults the next time AREPS is started.

If you have a project window open and active, and you have opened this window by selecting the Active Project item from the Options menu, any changes you make here will be reflected ONLY in the current active project. By choosing the Save button, the settings will be save in the project's initialization file. If you choose Apply, all changes will be immediately reflected in the current project.

Terrain range resolution

In previous versions of AREPS, the resolution of DTED terrain data used was fixed and unchangeable. Consequently, the terrain along a 15-kilometer maximum range graphic would look different than that of the first 15 kilometers of a 100-kilometer maximum range.

You may now select the resolution. You may divide the maximum project range into pieces, either by selecting the piece size in meters or selecting the number of pieces. Thus, for a maximum project range of 100 kilometers, either 1000 meters pieces or 100 pieces give the same resolution.

By default, we have set the resolution to that of the DTED level you are using. You will notice this default when you change the DTED level. For example, if you are using DTED level 1 data, the default resolution is 100 meters. If you are using DTED level 0 data, the default resolution is 1 kilometer. By doing this, we can use the DTED data points directly without having to interpolate between data points. Of course, you may use any resolution you desire.

Map display

There are a number of options that you may select for the project's DTED map. You may change the size of the map by changing the number of pixels or you may change the height resolution associated with each terrain color. These options may also be set from within each project by right-clicking on the DTED map. Future versions of AREPS will allow you to make changes to the terrain colors themselves, either individually or by selecting a color "scheme" from a list of choices.

THE ENVIRONMENT

Atmosphere Profile Creation Program Initialization Window

Upon starting the environment file creation program, it will look for the AREPS initialization file. If not found, you will be presented with the AREPS initialization window, figure 8-1. When you have provided the information asked for, just click the Continue command button. If you click the Cancel command button, the environmental input program will end.

For detailed information, please view the AREPS initialization window.

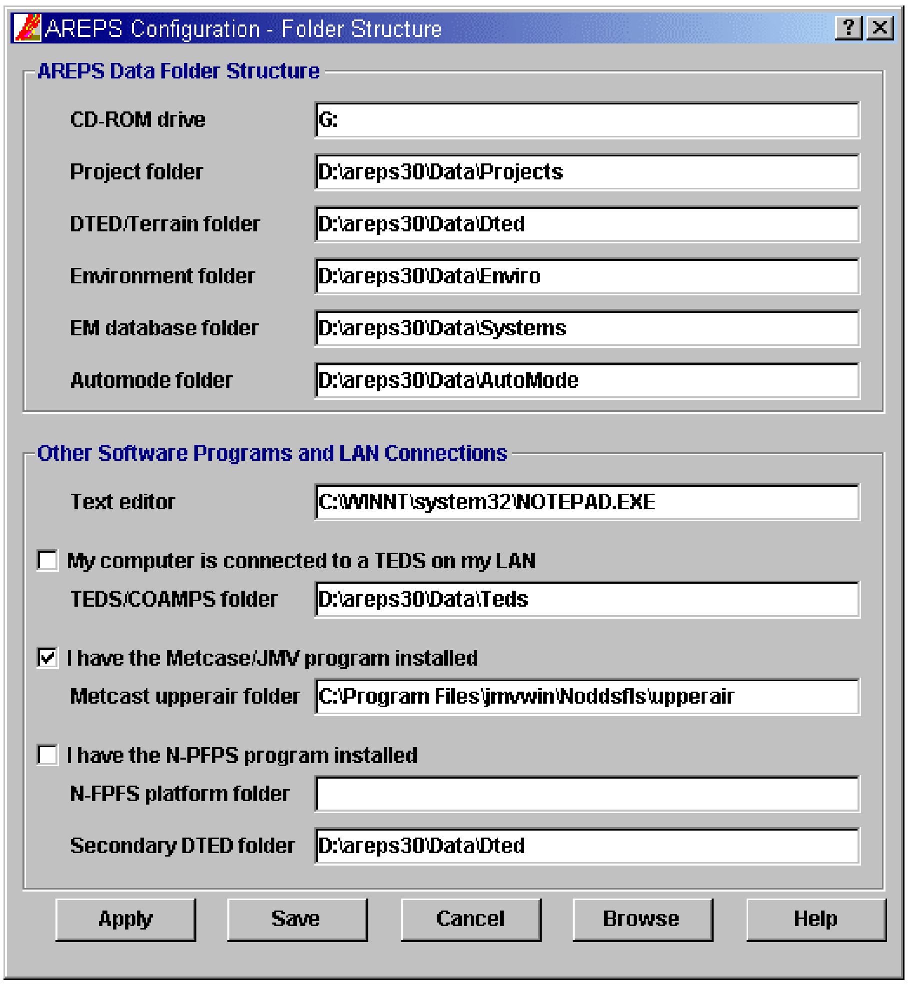


Figure 8-1: AREPS initialization window.

Navigating The Atmosphere Profile Creation Windows

The New environment window, figure 8-2, opens by selecting the New Environment item from the AREPS Environment menu or by clicking the New Environment () toolbar button. Since the atmosphere profile creation program is a stand-alone application, it may also be started from the Windows Start menu the same way that AREPS is started.

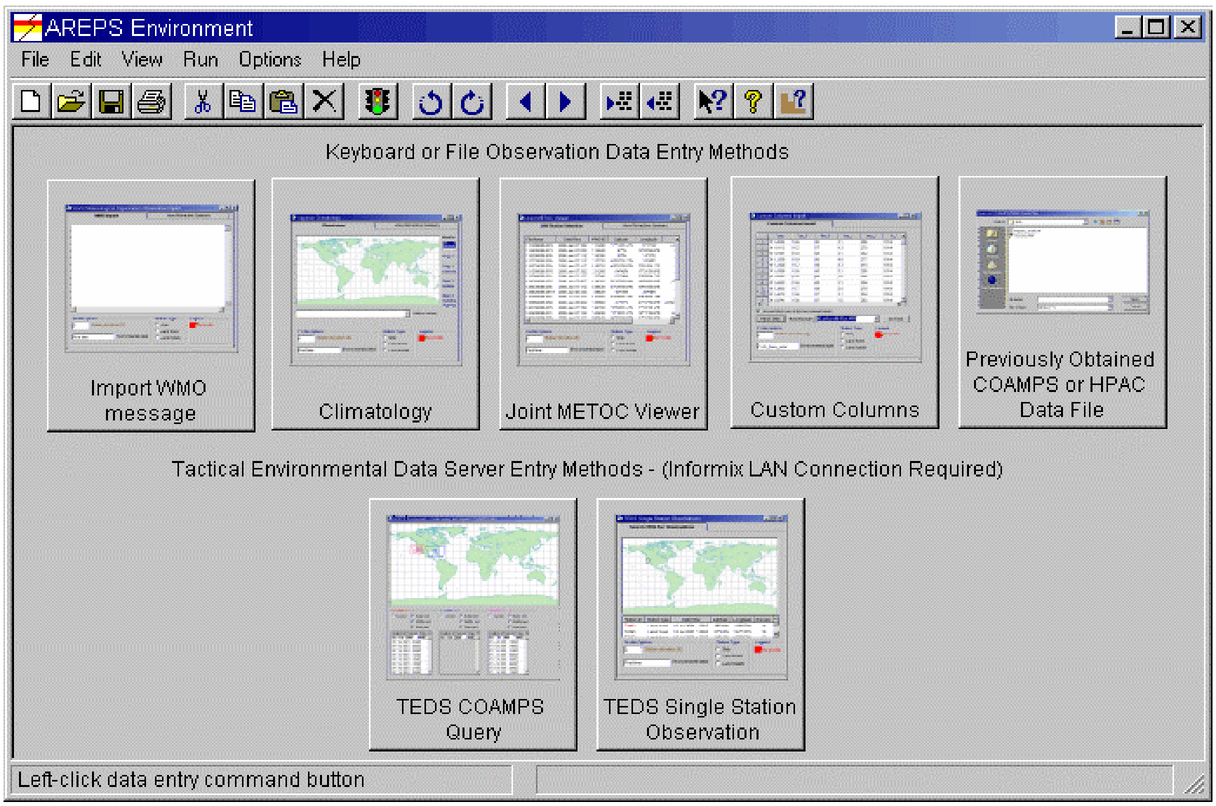


Figure 8-2: Environmental window.

Across the top of the program's main window is a menu system that controls all the program's functionality such as creating and displaying atmospheric environment data files, editing data input, viewing toolbars, setting program options, and obtaining help. All windows are opened, closed, and otherwise managed from the menu.

Below the menu system is a toolbar with icons that mirror the functionality of the menu system. The menu and toolbar system applies to all windows. The environment program automatically recognizes your active window and adjusts the menu text and toolbar functionality accordingly. Any menu or toolbar function that is not appropriate for your active window will be disabled. You have access to the menu and toolbar system at any time, except for when the Options windows and the Error window are opened. These windows require you to make a critical decision before the program can proceed.

At the bottom of the main window is a status bar. The status bar is divided into three panels. The left panel provides limit information about the input item that currently has your attention. The right panel provides information about how to select an item or other program status situations. The center panel shows the time consumed for certain calculations.

In the middle of the main window is a number of large quick action buttons for the various methods of entering environmental data. You may click on one of these quick action buttons as a shortcut bypass to the menu system.

Menus

File menu

Figure 8-3 illustrates the file menu. The New and Open menu items will be labeled appropriately for the environmental input method you have selected. For example, the picture above shows the labeling for the Custom Column method. You may **Open** World Meteorological Organization (WMO) code data, column, or tab-delimited data from ASCII text files. These files may be located on any network, hard, floppy, or CD drives.

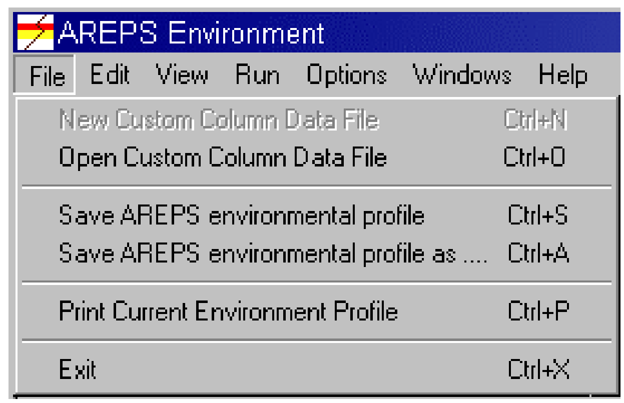


Figure 8-3: File menu.

It is not necessary to edit the data to eliminate extraneous text prior to opening it with the AREPS program. For WMO coded data, standard WMO code conventions are observed. For other data formats, AREPS will provide an editing window so you may adjust the data to the input method data requirements. The Open Tab-delimited Data File option will not be available from the menu unless your current input method is Custom Columns.

After you create an AREPS environmental input file, you may **Save** it with a name of your own choosing or create a **New** one. If your current environment is not saved, you will be asked to save it prior to creating a new one.

The Exit menu item will close the environmental window. If you are accessing the environment program from within AREPS, you will be returned to the main AREPS menu system.

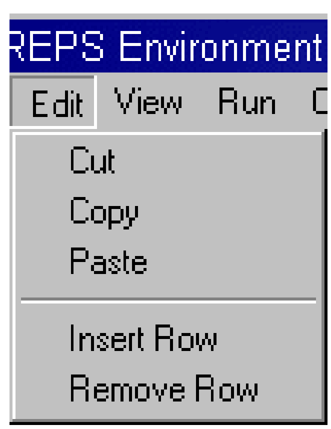


Figure 8-4: Edit menu.

Edit Menu

Figure 8-4 illustrates the Edit menu.You may use the Edit menu to **Cut**, **Copy**, and **Paste** text within any text input field. These commands are the same as used by all other Windows programs. If your current input point is a tabular form, you may use the **Insert Row** and **Remove Row** menu items to increase or decrease the number of rows in the form. Only the menu items appropriate to the input point are available from the menu.

View menu

Figure 8-5 illustrates the View menu. You may use the View menu to "toggle" on or off the display of the statusbar, toolbar, and toolbar captions. The check mark indicates the item is displayed.

For range and bearing dependent environments, you may also rotate the display in bearing and step in and out in range.

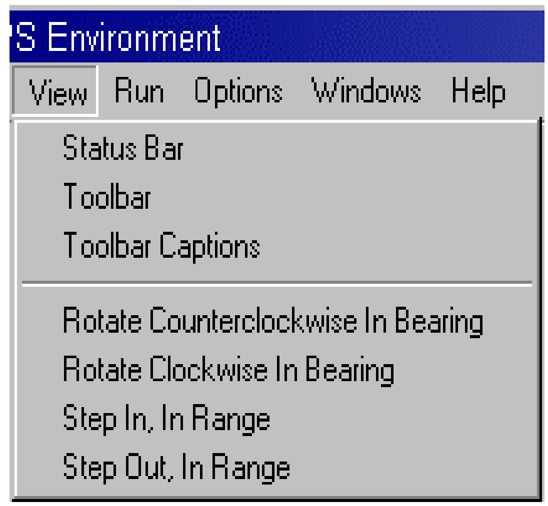


Figure 8-5: View menu.

Run menu

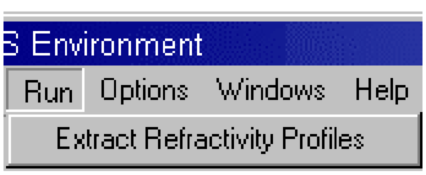


Figure 8-6: Run menu.

The Run menu of figure 8-6 (and toolbar button ) is the same idea as the AREPS program's run menu. In other words, the run menu is used to execute an operation. The run menu item will be labeled appropriately for the operation to execute. For example, the picture above shows the run menu item will extract an environmental profile from COAMPS gridded field data.

Options menu

The environmental program uses a number of options that are global to all operations. The AREPS program also uses some of these options. Setting such an

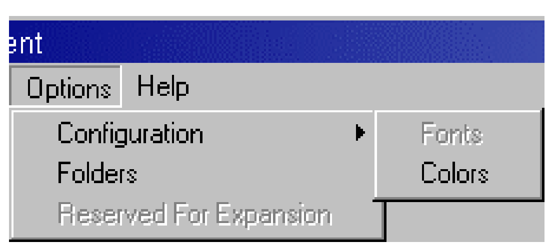


Figure 8-7: Options menu.

option within the environmental program, figure 8-7, does not set that same option within AREPS. You must use the Options menu item within AREPS to set all AREPS global options.

Help menu

You may use the Help menu, figure 8-8, to access the on-line help with the Contents item. The on-line help is also a stand-alone Windows help file. Since it is a stand-alone file, it may also be opened and viewed by double clicking on the areps.hlp file from the Windows Explorer window.

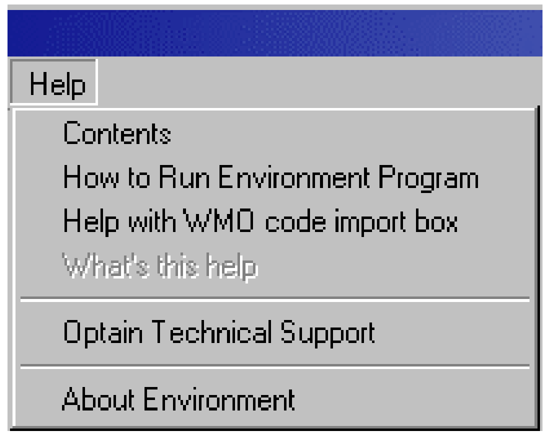


Figure 8-8: Help menu.

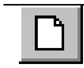
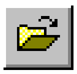
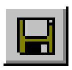
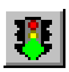
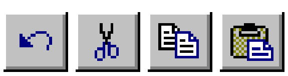
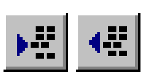
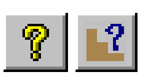
You may also obtain help on how to run the environment program and receive help for the particular item that currently has your attention. In the picture above, this particular item is the WMO code input box.

The Obtain Technical Support item provides instructions on how to contact the AREPS support team for questions, trouble reports, and other customer service features. The About item provides information on the current version of the environmental program.

Toolbar

Table 8-1 illustrates the toolbar buttons used by the atmosphere profile creation program. In every case, there is a corresponding menu item for the toolbar button.

Table 8-1: Environment window toolbar icons.

Toolbar icon	**Action**
	The New toolbar button clears all the tabs of previously entered data so you may create a new environment file without having to leave and reenter the environment window.
	The Open toolbar button opens a file containing an environmental observation. To function correctly, the file's contents must be radiosonde data in standard World Meteorological Organization (WMO) TEMP, TEMP SHIP, or TEMP MOBILE format.
	The Save toolbar button or the Save or Save As items from the AREPS file menu will create an environmental input file readable by AREPS. In addition to the height and *M*-unit profile, all data used in creating the profile are also saved within the file. Once saved, you are returned to the AREPS main menu.
	The Execute toolbar button is the same idea as the AREPS program's run menu. In other words, it is used to execute an operation. The run menu item will be labeled appropriately for the operation to execute.
	Perform editing functions such as undo, cut, copy, and paste.
	Insert or delete levels within a profile.
	Obtain help and open the helps steps window.

Atmosphere Profile Program Options

Folders

By choosing **Options** from the menu system, the options window opens. This window is the same as used for the program initialization, figure 8-1. When you have provided the information asked for, just click the **OK** command button. Your choices will be written into the environment program initialization file for future use. If you add either the JMV or TEDS capability, you must restart the environment program before you will have access to the JMV or TEDS windows. If you click the **Close** command button, your choices will be ignored.

Configuration - Colors

The atmosphere profile program uses colors to assist you in identifying many features. These colors are illustrated in figure 8-9. Two examples are the refractivity legend and the COAMPS areas. You may change any color simply by clicking on the label of the item you want to change colors for and selecting a color from the change color popup window, figure 8-10. If the color you want is not shown in the little boxes, click the **Define custom colors** button. The window will expand, figure 7-3, showing you a rainbow colored box. Click and drag the mouse over the rainbow of colors. As you do, your current color will show in the box labeled Color|Solid. When you have the color you want, click the **OK** button.

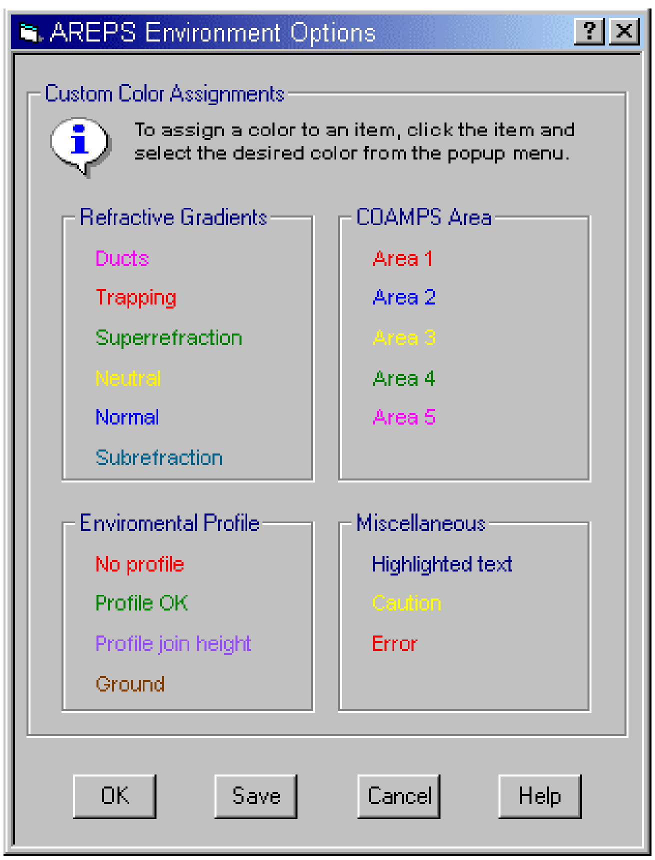


Figure 8-9: Configuration – colors window.

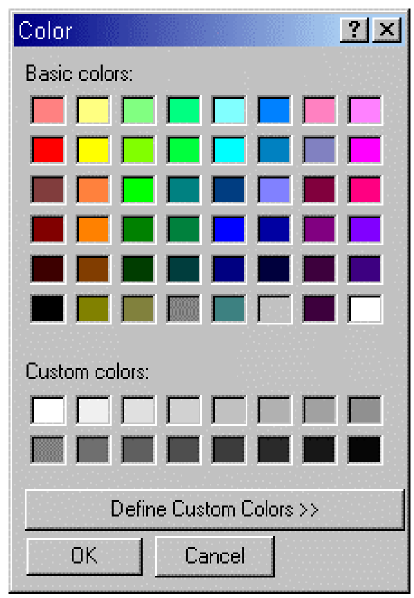


Figure 8-10: Change color popup window.

Common Input Fields

Common to all profile creation methods are a number of input fields and other information displays. These common features apply universally to all input methods. These common fields are:

Environmental label

The environmental label, figure 8-11, shows on the decision aid to help identify the environmental input. You are limited to 16 characters including spaces. You may edit or delete this label as you wish.

Figure 8-11: Environmental label.

If you are using either the Import WMO Message tab, a label for your environmental file will be automatically created from the date/time of the message. Because the WMO message does not contain the month or year information, they are taken from your computer's internal clock.

If you are using either the Climatology tab or the Joint METOC Viewer tabs, the label for your environmental file will be automatically set to the station name.

Station type

If WMO code is entered by reading the data from a file, the data header UUBB (ship), TTBB (fixed land), or IIBB (mobile land) will determine which type of radiosonde station is being used as illustrated in figure 8-12. In a like manor, data from climatology, the Joint METOC Viewer, or the TEDS single station observation will determine the station type.

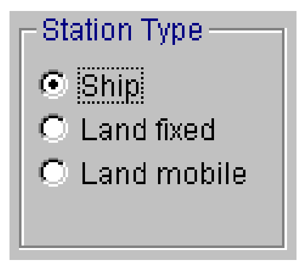


Figure 8-12: Station type.

Once the station type is determined, you may not change it without creating a whole new profile. If you are using the Refractivity summary tab to enter data via the keyboard, you must specify the station type by selecting the appropriate option button. If a land station is selected by any method, you still will have access to the Evaporation duct input fields. However, you will receive a warning about appending an evaporation duct onto a land station profile. Normally, you should only consider this when the station is located at the coast and the meteorological conditions are such that the land stations reflects the conditions over the water.

Station elevation

If the station elevation is known, you may enter it into the station elevation input field, figure 8-13. For example, if the data were obtained from a radiosonde launched from the flight deck of an aircraft carrier, the flight deck height would be used for the station elevation.

Figure 8-13: Station elevation.

In some cases, the station elevation may be known from other sources. For example, station elevation is provided in the header information for a WMO mobile land station's report (IIBB) or is provided from climatology. For these two cases, station elevation is entered automatically for you. Should the station elevation be non-zero, a zero height level (sea level) will be extrapolated using either the M-unit gradient between the first two profile levels or a standard atmosphere gradient. You may select which of these options to use from the **Option** menu. You may change the units by right clicking on the station elevation label and selecting the new units from the popup menu.

As a visual aid, the station elevation label is colored brown. This color corresponds to the station elevation line drawn on the environmental summary display.

Profile legend

The profile legend, figure 8-14, describes the current state of your atmospheric profile and your individual inputs. If a valid height versus M-unit profile exists, the legend will read "Profile OK". If not, the legend will read "No profile."

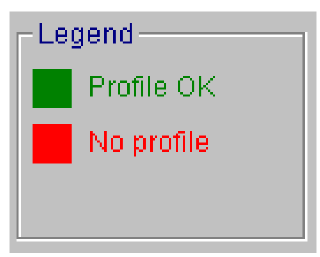


Figure 8-14: Profile legend.

If you are entering data and an individual input value is unacceptable (i.e., a negative Kelvin temperature), its input field's background color will show red. If an individual input value is within bounds but not recommended (i.e. an evaporation duct height greater than 40 meters), its input field's background color will show yellow.

World Meteorological Organization Message

Import WMO message window

If World Meteorological Organization (WMO) code data are available within a file or are available within the Windows clipboard, select this environment creation method, figure 8-15, by clicking on the WMO quick start command button.

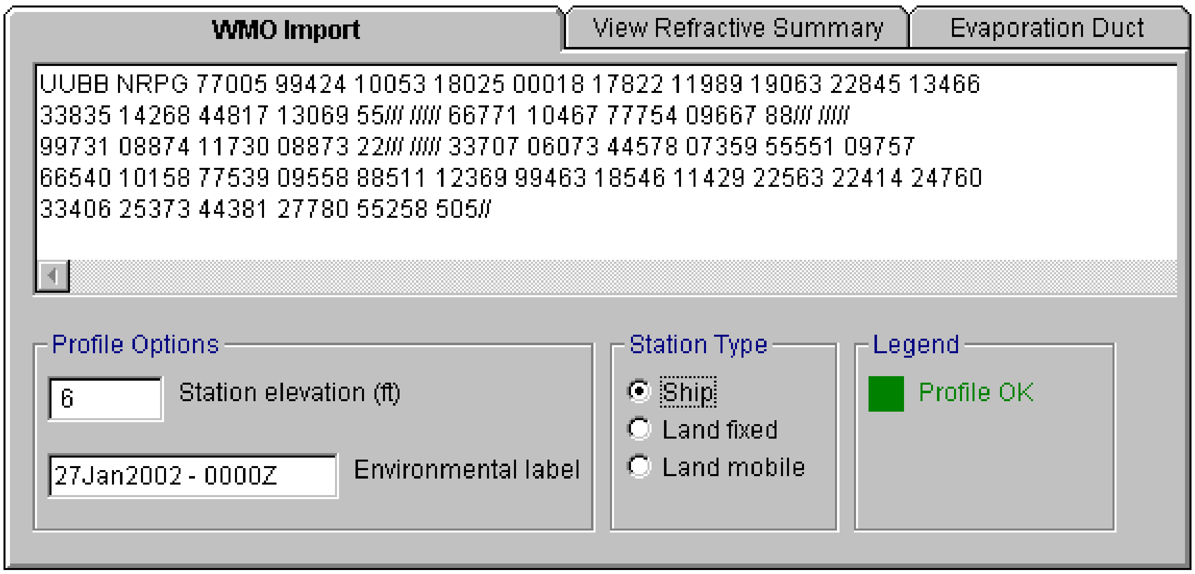


Figure 8-15: Import WMO message window.

If the data are in a file, you may open and read its contents directly using the **Open** item from the file menu or clicking the **open** toolbar button. Alternatively, you may drag and drop the file name from the Windows Explorer window into this window. The file may be located on any drive (network, your own hard drive, or a floppy diskette). If the data is available within the Windows clipboard, you may paste them into the tab by using the **Paste** item of the edit menu, **Paste** toolbar button, the right mouse click menu, or the standard Windows keystroke commands.

As an example of this technique of data import, open the sample WMO code message file, provided by the AREPS installation program, using the Windows Notepad program. The name of this file is sample_radiosonde.txt and is located in the enviro folder. Highlight the entire text and copy it to the clipboard using the standard Windows commands. Then left click in the import data text box and perform the Paste procedure.

The contents of the data may include text other than standard WMO code text. It is not necessary to edit the data to eliminate extraneous text prior to opening it with the AREPS program. AREPS uses standard WMO code conventions when parsing the data.

For example, if the text "UUBB", "TTBB", or "IIBB" is not found within the data, the data will not be processed.

Error checking is performed as the data are processed. If no errors are found, the legend will read Profile OK with the text colored green. If an error is found, it will be highlighted in the import data text box. You may then use the editing (Undo, Cut, Copy, and Paste) toolbar buttons or the standard Windows editing shortcut keys (found on the right mouse button click menu) to correct any errors.

If you know the station height, you may enter it in the station height input field. You may also enter a label of your choice. By default, the label is the date/time of the message. Because the WMO message does not contain the month or year information, they are taken from your computer's internal clock.

If you wish, you may select the Refractivity Summary tab or the Evaporation duct tab to view the data. Viewing the data prior to saving the profile is not necessary. Viewing the refractivity summary however, would alert you to possible errors in the processed WMO code. For example, poorly ventilated radiosondes will often show the top of a superrefractive, subrefractive, or trapping layer to be at a pressure of 1000 millibars. Once WMO code is processed from a file or the clipboard, you may edit the data within any field within any tab.

World Meteorological Organization (WMO) Code

The World Meteorological Organization defines a meteorological message as a message comprising a single meteorological bulletin. AREPS uses the TEMP, TEMP SHIP, or TEMP MOBILE message formats. The message is composed of five-character figure groups divided into two parts labeled XXAA and XXBB, where XX is replaced with TT for fixed land stations, II for mobile land stations, and UU for ship stations. The XXAA section reports data for mandatory isobaric surfaces. The mandatory levels are isobaric surfaces of 1000, 925, 850, 700, 500, 400, 300, 250, 200, 150, and 100 millibars (hectopascals). Section XXBB reports data for significant levels with respect to pressure, temperature, and humidity. The AREPS program uses the XXBB portion of the WMO message.

In general, a significant level is defined as a level at which temperature and/or relative humidity data are sufficiently important, or unusual, to warrant the attention of a forecaster (such as cloud bases or icing strata) or to allow for precise plotting of the radiosonde observation. The criteria for determining significant levels for international exchange is based on the premise that significant level data alone shall make it possible to reconstruct the air temperature and relative humidity curves. These criteria are:

1. For temperature at pressures of 300 millibars or greater, the temperature between two adjacent levels should not differ more than 1 degree Celsius from that obtained by linear interpolation between the two selected levels.

2. For relative humidity at all pressures, the relative humidity between two adjacent levels should not differ more than 10 percent from that obtained by linear interpolation between the two selected levels.

3. Surface data.

4. Bases of clouds and icing strata.

5. The highest and lowest temperature on the plotted curve from the surface up to and including the terminating level.

6. The highest and lowest humidity on the plotted curve from the surface up to and including the terminating level.

7. The boundary levels of a stratum whose temperature and/or humidity is missing or doubtful.

8. The lower boundary of a stratum of more than 50 millibars in extent for which humidity is missing, provided the humidity values continue to be missing for the remainder of the ascent.

9. Termination of the ascent.

10. Whenever a series of relatively thin strata (approximately 100 meters thick) having different lapse rates occur adjacent to one another, data for only the lowermost and uppermost of such levels will be transmitted.

Five-Character Figure Groups

Station Identification Group

The WMO system of index numbers for identifying observing stations consists of two parts: a block number and a station number. When these two numbers are combined, the resulting group provides a unique number for each station. Block numbers are allocated to countries or geographic areas by the WMO. Each block number identifies 1000 station numbers assigned by the specific country. The first digit of the station number is a north/south indicator with smallest digits to the south and largest digits to the north of the block. The last two digits are an east/west indicator with the smallest digits to the east and largest digits to the west of the block. The format of the group is IIiii where:

II =
Block number
iii =
Station number

Date and Time group

This group reports the date and time of the observation. The format of the group is YYGGI where:

YY =
day of month (+50 if winds are reported in knots)
GG =
nearest whole hour (Greenwich Mean Time)
I =
hundreds of millibars relative to last wind surface

Latitude Group

This group reports the latitude of the observing station. The format of this figure group is 99LLL where:

99 =
indicator for sea station.
LLL =
latitude, degrees, and tenths.

Longitude Group

This group reports the longitude of the observing station. The format of this group is QLLLL where:

Q =
quadrant of globe. 1=NE, 3=SE, 5=SW, 7=NW. The north/south

line is 0 degrees latitude and the east/west dividing line is 0

degrees longitude.
LLLL =
longitude, degrees, and tenths

Marsden Square Group

As a way of grouping meteorological observations for climatology purposes, the entire world is divided into 10-degree by 10-degree squares called Marsden squares. A map of these Marsden squares may be found in the Surface Duct Summary program of EREPS. This WMO code group defines the Marsden square of the observing station. The format of this group is MMMUU where:

MMM =
Marsden square number for ship location.
U =
Units digit of latitude.
U =
Units digit of longitude.

Station Elevation Group

For mobile land stations, the elevation of the reporting station is given together with the elevation units and the accuracy of the elevation. The format of this group is $h_oh_oh_oh_oi_m$ where:

$h_oh_oh_oh_o$ = Station elevation
i_m = Units and accuracy of station elevation.

The reported units and accuracy of the station elevation are defined in the WMO code table 1845 and illustrated in table 8-2.

Table 8-2: WMO code table 1845.

Code figure	Units used	Confidence factor
1	meters	Excellent (within 3 meters)
2	meters	Good (within 10 meters)
3	meters	Fair (within 20 meters)
4	meters	Poor (more than 20 meters)
5	feet	Excellent (within 10 feet)
6	feet	Good (within 30 feet)
7	feet	Fair (within 60 feet)
8	Feet	Poor (more than 60 feet)

Significant Pressure Groups

This group reports the pressure for a significant (or surface) level. The format of this figure group is 00PPP where:

00 =
indicator for surface data (99 if land station).
PPP =
extrapolated surface pressure in whole millibars (hectopascals),

hundreds, tens, and units, i.e., 1013.2 mb = 013 or 987.2 mb = 987.

All remaining pressure groups are significant levels. The format of these figure groups is XXPPP where:

XX =
indicator for significant level. Significant levels are consecutively

numbered 11, 22, 33, etc., and are repeated after 99.
PPP =
pressure in whole millibars (hectopascals), hundreds, tens, and

units, i.e., 1004.2 mb = 004 or 457.2 mb = 457.

When a stratum of missing data occurs and observed data are available below and above the missing stratum, a set of data is inserted to represent the missing stratum. For example, if a missing stratum occurs following the second significant level, the coding would be 33///, with the solidi (///) serving as place holders.

Significant Temperature Groups

These groups report the temperature and dewpoint depression temperature for a significant (or surface) level. The format of this figure group is TTTDD where:

TT =
air temperature in whole degrees Celsius.
T =
approximate tenths value, even for positive temperatures and odd

for negative temperatures.
DD =
depression of dewpoint temperature with respect to water.

Subtract the dewpoint depression from the air temperature to obtain the dewpoint temperature. The reported numbers are from WMO code table 102 and illustrated in table 8-3.

Table 8-3: WMO code table 102.

00 = 0.0 C	50 = 5.0 C
01 = 0.1 C	51-55 are not used
02 = 0.2 C	56 = 6.0 C
. . .	57 = 7.0 C
. . .	. . .
. . .	98 = 48.0 C
49 = 4.9 C	99 = 49.0 C or more

All remaining temperature groups are associated with significant levels. The format of these figure groups is the same as above. If only the dew point temperature depression is missing, the group is reported as TTT//, with the solidi (//) serving as placeholders. If the temperature is also missing, the group is reported as ///// with the corresponding pressure group also reported as XX///. When entering temperature groups, just enter the // for the dewpoint depression only, i.e., skip the whole level for which the pressure group is XX/// and the temperature group is /////.

Refractivity Summary Tab

This tab, figure 8-16, is automatically completed by all the various input methods. However, if you only have data on paper and need to make an entry over the keyboard, you may do so here. You may enter heights and refractivity values, or pressure, temperature, and humidity (either as dewpoint temperature, dewpoint depression temperature, or relative humidity) values.

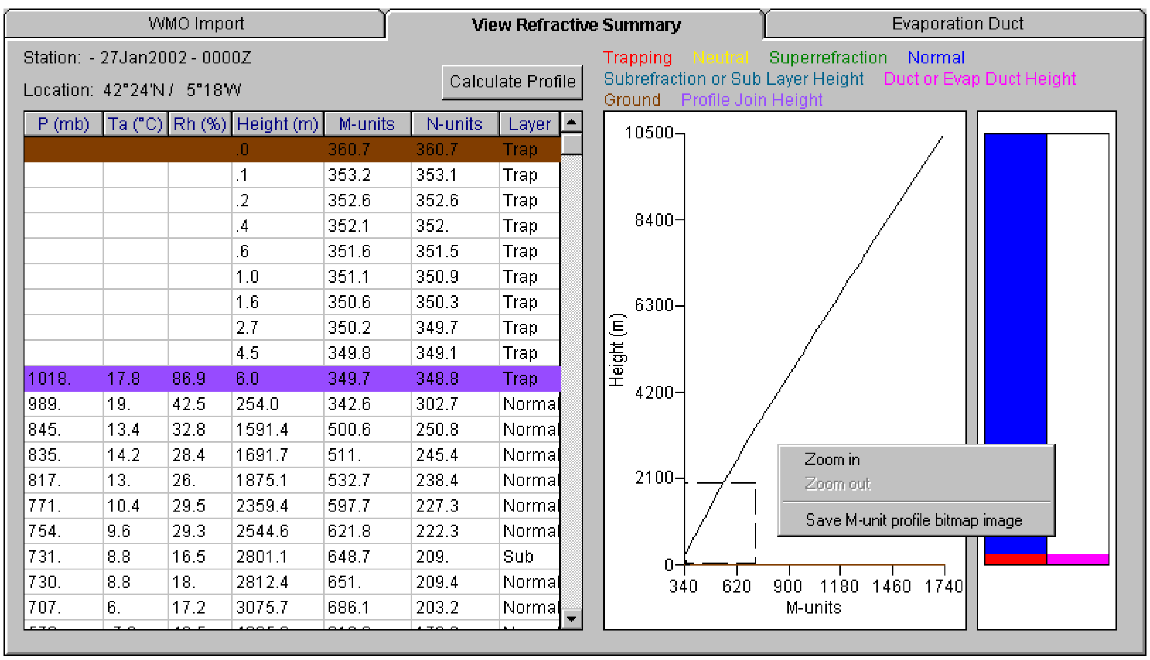


Figure 8-16: View refractivity summary tab.

As data are entered in the profile tabular form, the profile will be created. Once a level has sufficient data, a description of the refractive condition between that level and the previous level is displayed in the right most column. These conditions are Sub (subrefraction), Neutral (zero M-unit gradient), Normal, Super (superrefraction), and Trap (Trapping).

If the tabular form contains a profile that contains an appended evaporation duct, the height of the appended evaporation duct profile is colored. In addition, the station elevation height is also colored. The color legend above the graphic shows the definitions of colors. You may change the color definitions from the Colors item of the Options menu.

In addition to viewing or entering the profile data, the refractivity summary tab shows the existing refractive conditions for the environmental data entered. The display on this tab is similar to that of the propagation condition summary window within the AREPS main program. The environmental summary show modified refractivity (M-units), refractive gradients, and ducts as a function of altitude. If the station elevation is not zero, a brown line is also drawn at its height. By right clicking on the height versus M-unit picture, a popup menu will open allowing you to perform zoom and other functions.

You may use this summary tab to assess the reliability of your environmental data prior to saving it for use in AREPS. Rapid fluctuations in refractivity or unusually sharp gradients in refractivity, both of which may be caused by environmental input errors or improper environmental assessment methods, will become obvious by inspecting the profiles. In addition, the profiles may be inspected to insure meteorological consistency. For example, if a Foehn condition is known to exist, there should be an indication of a surface-based duct. The evaporation duct height should be inspected. Any evaporation duct height greater than 40 meters should immediately be suspect.

Profile tabular form

Normally, this tabular form will be completed automatically by your method of environmental input. However, you may construct a modified refractivity profile by entering into the tabular form figure 8-17, data as triplets of pressure, temperature, and humidity or by couplets of height and refractivity or modified refractivity over the keyboard. After you have entered your data, click the **Calculate Profile** button.

Station: - 27Jan2002 - 0000Z

Location: 42°24'N / 5°18'W

Calculate Profile

P (mb)	Ta (°C)	Rh (%)	Height (m)	M-units	N-units	Layer
			.0	360.7	360.7	Trap
			.1	353.2	353.1	Trap
			.2	352.6	352.6	Trap
			.4	352.1	352.	Trap
			.6	351.6	351.5	Trap
			1.0	351.1	350.9	Trap
			1.6	350.6	350.3	Trap
			2.7	350.2	349.7	Trap
			4.5	349.8	349.1	Trap
1018.	17.8	86.9	6.0	349.7	348.8	Trap
989.	19.	42.5	254.0	342.6	302.7	Normal
845.	13.4	32.8	1591.4	500.6	250.8	Normal
835.	14.2	28.4	1691.7	511.	245.4	Normal
817.	13.	26.	1875.1	532.7	238.4	Normal
771.	10.4	29.5	2359.4	597.7	227.3	Normal
754.	9.6	29.3	2544.6	621.8	222.3	Normal
731.	8.8	16.5	2801.1	648.7	209.	Sub
730.	8.8	18.	2812.4	651.	209.4	Normal
707.	6.	17.2	3075.7	686.1	203.2	Normal

Figure 8-17: Profile tabular form.

You may change units of any column by right mouse clicking on the column label. For example, the units of humidity may be changed between relative humidity, dew point temperature, or dew point depression temperature by clicking on the label at the top of the humidity column.

The Insert and Remove items of the Edit menu or the corresponding toolbar buttons work within this tab. Inserting a row will open a new level above the current cursor location. The level to be deleted is shown by the current cursor location.

The third column of the profile tabular form contains humidity values. Humidity may be entered in three forms, relative humidity (%), dew point temperature (F, C, or K), or dew point depression temperature (F, C, or K). Note that while all temperatures are either Fahrenheit or Celsius, the concept of dew point depression units (Celsius degrees) is different from the air or dew point units (degrees Celsius). The dew point depression is the difference in degrees between the air temperature and the dew point. Therefore, in any dew point depression unit conversion, the constant of 32 is not used. That is, 1 Celsius degree equals 1.8 Fahrenheit degree while 1 Celsius equals 33.8 Fahrenheit.

Height versus modified refractivity graphic display

The refractivity summary display contains a height versus modified refractivity display, figure 8-18.

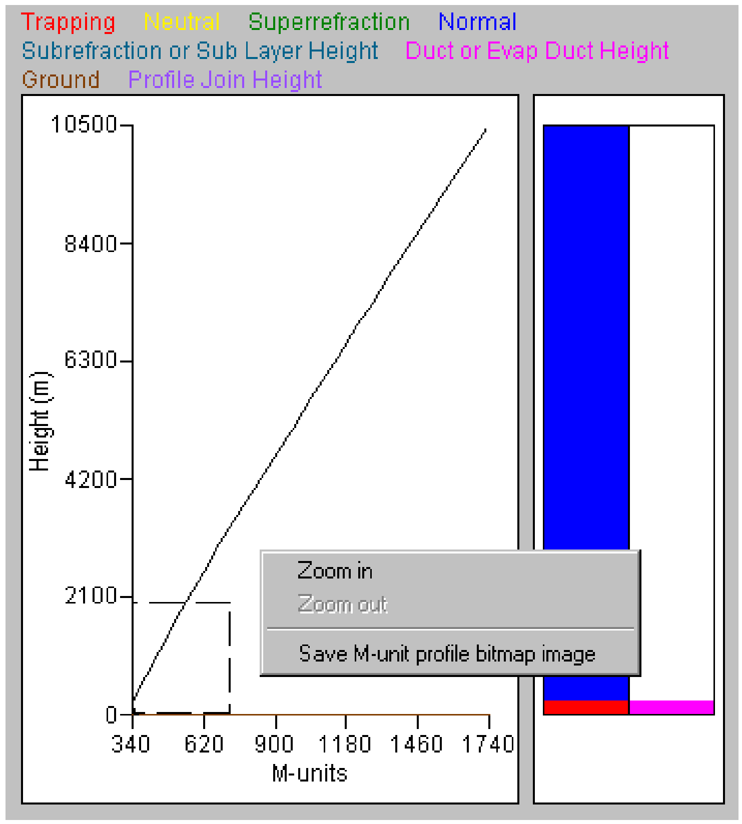


Figure 8-18: Height versus modified refractivity graphic display.

As the mouse moves about the graph, the values of height and refractivity show in the left status bar. If you click the left mouse button anywhere within one of these graphs, a rubberband box will open. By holding down the left mouse button, you may expand, contract, or drag the rubberband box about the graph. By right clicking the mouse anywhere within the graph, a popup menu will appear. If the rubberband box is visible, you may use this menu to zoom the graph to the dimensions of the rubberband box. You may then make a closer inspection of the profile.

Ducting and refractive gradients bar graph

The ducting and refractive gradient bar graph, figure 8-19, consists of two sides. The refractive gradient is displayed on the left and the ducts are displayed on the right.

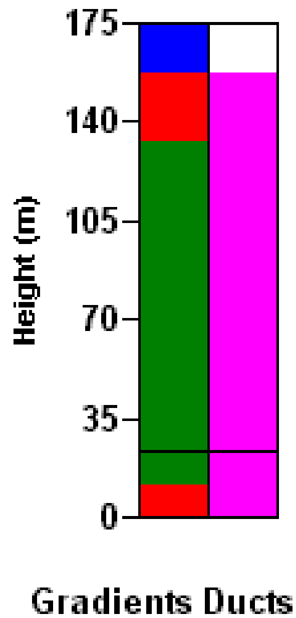


Figure 8-19: Ducting and refractive gradient bar graph.

As a visual aid, the refractive gradient is color-coded. Trapping is red, neutral (no refractive gradient) is yellow, superrefraction is green, normal is blue, and subrefraction is cyan. The ducts are colored in magenta. If the station elevation is not zero, a brown line is drawn at its height. For a land station, the refractive gradients and ducts below the station elevation are artificial and are properly considered in AREPS. For a ship (aircraft carrier) station however, the station elevation line may be at the flight deck level. In this case, the refractive gradients are valid down to a height of zero (sea level).

Note in the example, there is a trapping layer that extends from about 130 meters upward to 155 meters. This corresponds to an elevated trapping layer. There is also a trapping layer from the surface upward to a height of 10 meters. This corresponds to the trapping of an evaporation duct. You can see, however, the elevated trapping layer is sufficiently strong as to create a surface-based duct that will dominate the propagation.

Evaporation duct tab

You may use this tab, figure 8-20, to create an evaporation duct profile.

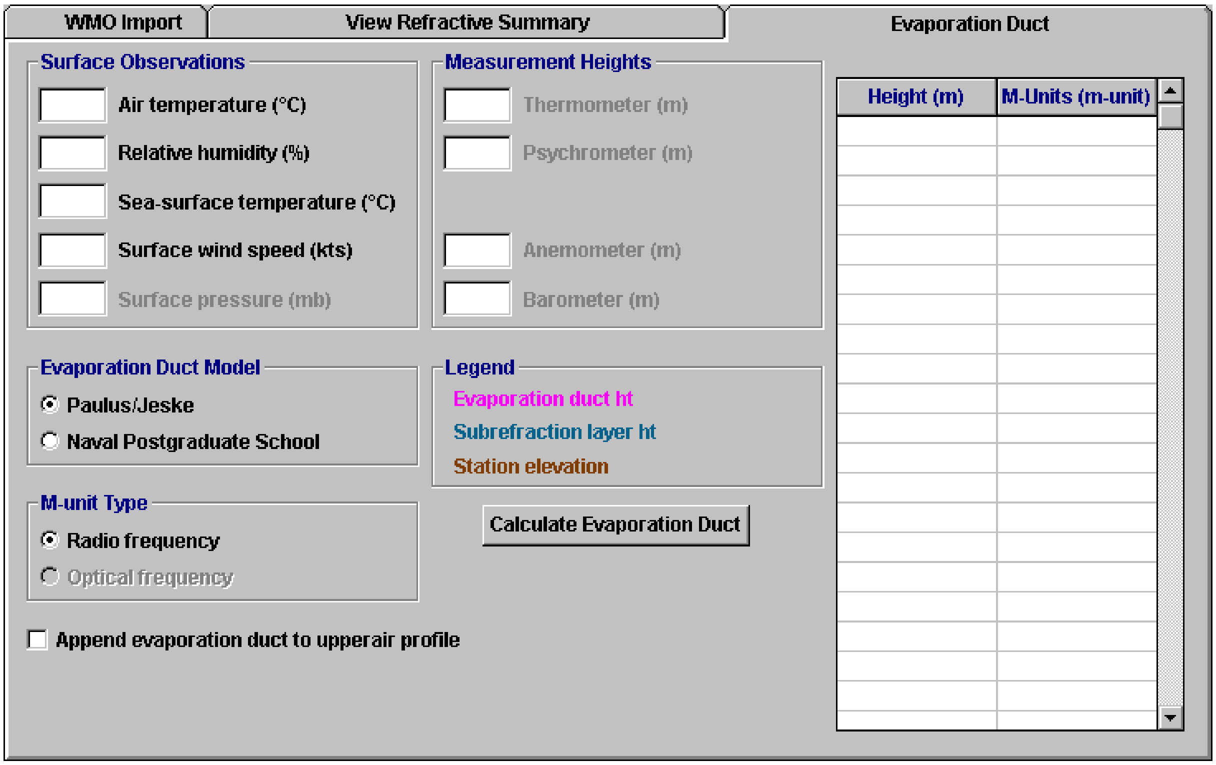


Figure 8-20: Evaporation duct tab.

If you enter a ship radiosonde from the Import WMO message window, a neutral profile (air and sea surface temperature are equal) evaporation duct will be automatically calculated and merged with the upper-air data from the radiosonde. For this calculation, the surface level of the radiosonde is assumed to occur at an altitude of 6 meters (or the non-zero station elevation if entered). In either case, a surface (sea-surface) M-unit value will be calculated for the required evaporation duct height and the evaporation duct and upper-air profiles will be merged at the station elevation. You may prevent the automatic merge of an evaporation duct by unchecking the Append evaporation duct to upperair profile checkbox.

If no radiosonde is entered, you may create just an evaporation duct profile by either entering a value for surface temperature, humidity, sea-surface temperature, and wind speed. After you enter these observations, you must then click the **Calculate Evaporation Duct** command button. Should you choose the NPS model, you must also provide measurement heights for all the surface observations. For AREPS 3.0, we have removed the capability of entering an evaporation duct height and a Richardson number or a Monin-Obukhov length stability parameter.

If a land station radiosonde is entered by any method, you will have access to the Evaporation Duct tab but you will also receive a warning about appending an evaporation duct profile onto the bottom of a land station profile. We allow you this option in case the land station is along the coast and you feel its data are representative of that over the water.

The evaporation duct profile appends onto the bottom of the upper-air profile at the time the evaporation duct is calculated. Should you return to your original input tab and change something, please understand you must return again to the evaporation duct tab to recalculate the evaporation duct prior to saving the profile into a file.

Evaporation Duct Model

AREPS provides two evaporation duct models. The first (and the default) is the Paulus/Jeske model as used in previous versions of AREPS. The second is the Naval Postgraduate School (NPS) model. You may choose which model you would like to use by clicking the appropriate option button. We provide the NPS model as a convenience for those "researchers" who may want to use the model in a user-friendly format.

The Paulus/Jeske model is used for neutral profile and all calculations for which you have chosen to append the evaporation duct to the bottom of an upper-air profile. This is because, the NPS model may not converge to an answer under some stable atmosphere conditions. Since there is no "evaporation duct height" (a minimum M-unit value on the height versus M-unit profile) determined, there is no height at which to join the two profiles.

For the Paulus/Jeske model, when entering the surface observation values of air temperature, sea-surface temperature, humidity, and wind speed, these values may produce a subrefractive layer instead of an evaporation duct. Should this be the case, the appropriate M-unit profile will be calculated and displayed.

Surface Observations

Air Temperature

The surface temperature of the air is best measured at any location above 6 meters (20 feet). Be careful to minimize any ship-induced effects such as heating from exhaust vents or radiating surfaces. The units may be F, C, or K.

Humidity

The surface humidity may be entered in three forms, relative humidity (%), dew point temperature (F, C, or K), or dew point depression temperature (F, C, or K). To change the humidity type and units, right click on the label. The humidity is best measured at the same location with the air temperature.

Note that while temperatures may be either Fahrenheit or Celsius, the concept of dew point depression units (Celsius degrees) is different from the air or dew point units (degrees Celsius). The dew point depression is the difference in degrees between the air temperature and the dew point. Therefore, in any dew point depression unit conversion, the constant of 32 is not used. That is, 1 Celsius degree equals 1.8 Fahrenheit degree while 1 Celsius equals 33.8 Fahrenheit.

Sea-surface Temperature

The temperature at the sea surface is best measured with an accurate thermometer and a small bucket lowered into undisturbed water. Satisfactory measurements are also obtainable by using the surface temperature from an expendable bathythermograph (XBT) if the XBT is not launched into the wake.

Injection water temperature measurements are very inaccurate for the purpose here and should be avoided if another temperature source is available.

Surface Wind Speed

The true wind speed at the sea surface is best measured at the location of the air temperature and humidity measurements. The units may be knots or meters per second.

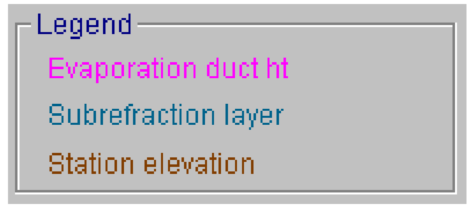
Surface pressure

The atmospheric pressure at the sea surface, best measured at the location of the air temperature and humidity measurements. The NPS evaporation duct model requires this input.

Measurement Heights

The NPS evaporation duct model requires the instrument heights associated with the surface observations of air temperature, humidity, wind speed, and pressure. Right-click any label to change units.

Evaporation duct legend



As AREPS calculates the evaporation duct, the duct height will have a relationship with the station elevation. In addition, the calculation may produce a subrefractive layer rather than an evaporation duct. As a visual aid, the evaporation duct height, the station elevation, the profile join height, and the subrefractive layer height will be color-coded in the profile tabular form and the evaporation duct tabular form. You may change the color assignments from the Configuration Colors item of the Options menu.

Evaporation Duct Profile

When an evaporation duct or subrefractive profile is created, it is displayed in the tabular form. The form is for display only and you may not edit any numbers within it.

If an evaporation duct profile has been created from the evaporation duct tab by entering surface observations, this tabular form displays only the evaporation duct profile. For the Paulus/Jeske model, the profile calculation is continued beyond the evaporation duct height until a standard atmosphere gradient is achieved. As a visual aid, the background color for the evaporation duct height and M-unit values is colored magenta.

Height (m)	M-units
2.718	319.75
4.482	319.
7.389	318.53
10.756	318.41
12.182	318.43
20.086	318.83
33.115	320.
54.598	322.34
90.017	326.57
148.413	333.84
244.692	346.09
403.429	366.49

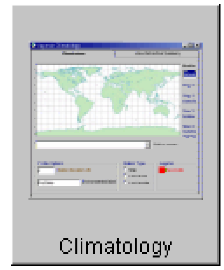
Height (m)	M-units
0.	360.58
0.135	353.01
0.223	352.47
0.368	351.93
0.607	351.4
1.	350.9
1.649	350.43
2.718	350.01
4.482	349.68
6.	349.55

If the station elevation is zero and you have elected to merge the evaporation duct profile with an upper- air profile, the merged height is set to 6 meters. As a visual aid, the background color for the merged height and M-unit values is colored brown. While the actual calculated evaporation height may or may not be included within the profile, the appropriate gradient for that height is represented in the M-unit values from sea level to 6 meters.

Height (m)	M-units
0.223	343.27
0.368	341.79
0.607	340.35
1.	339.
1.649	337.77
2.718	336.7
4.482	335.85
7.389	335.28
11.804	335.07
12.182	335.08
20.086	335.4
23.	335.61

If the station elevation is not zero and you have elected to merge the evaporation duct profile with an upper-air profile, the background color for the station elevation and M-unit values is shown in brown. If the evaporation duct height is less than the station elevation, the background color for evaporation height is shown in magenta. If the station elevation is less than the evaporation duct height, the calculated evaporation duct height is not included within the profile, but the appropriate gradient for that evaporation duct is represented in the M-unit values from sea level to the station elevation.

Climatology Tab



GTE Sylvania, under contract to the Department of Defense, conducted a large- scale analysis of approximately 3 million worldwide radiosonde soundings from 921 observing stations. Numerous statistics of tropospheric ducts and super-refractive layers were compiled. Using the Climatology tab illustrated in figure 8-21, you may construct an *M*-unit profile based upon the statistics of the survey. To open the climatology tab, click on the Climatology quick start command button.

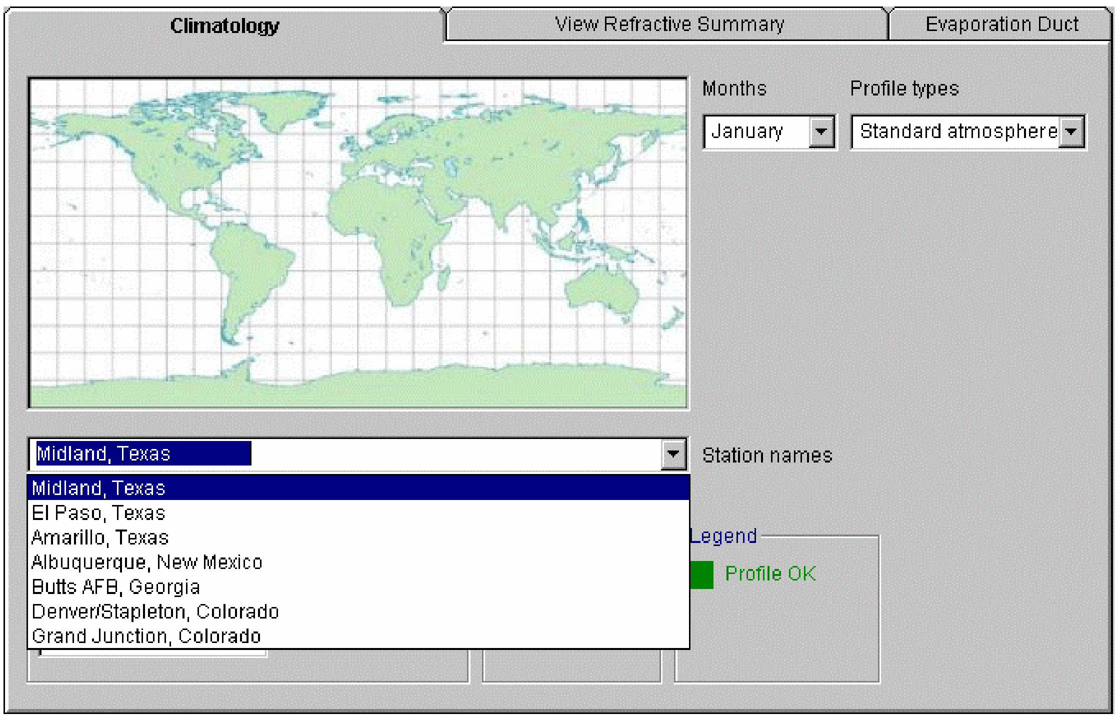
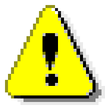


Figure 8-21: Climatology tab.

As the mouse cursor moves about the map, its latitude, longitude, and Marsden square location are shown just above the map. Clicking on the map will fill the station name dropdown menu with the names of all the observing stations within the Marsden square.

Select a station name from the name dropdown menu, a month of interest from the month dropdown menu, and a profile type from the profile type dropdown menu. The profile types may be standard atmosphere, surface-based duct, elevated duct, and a combination of surface-based and elevated ducts. As the profiles are created, the percent occurrence of such a profile shows in the right status bar panel.



Please note the profile you select may occur only a very small percentage of the time. For these cases, you must ensure the ultimate user of the decision aid understands the likelihood of the environment.

After entering a climatology profile, you will have access to the Evaporation Duct tab, but you will also receive a warning about appending an evaporation duct profile onto the bottom of a land station profile. We allow you this option in case the land station is along the coast and you feel its data are representative of that over the water.

The evaporation duct appends onto the bottom of the climatology profile at the time the evaporation duct is calculated. Should you return to the climatology tab and change something, please understand you must return again to the evaporation duct tab to recalculate the evaporation duct prior to saving the profile into a file.

Marsden square

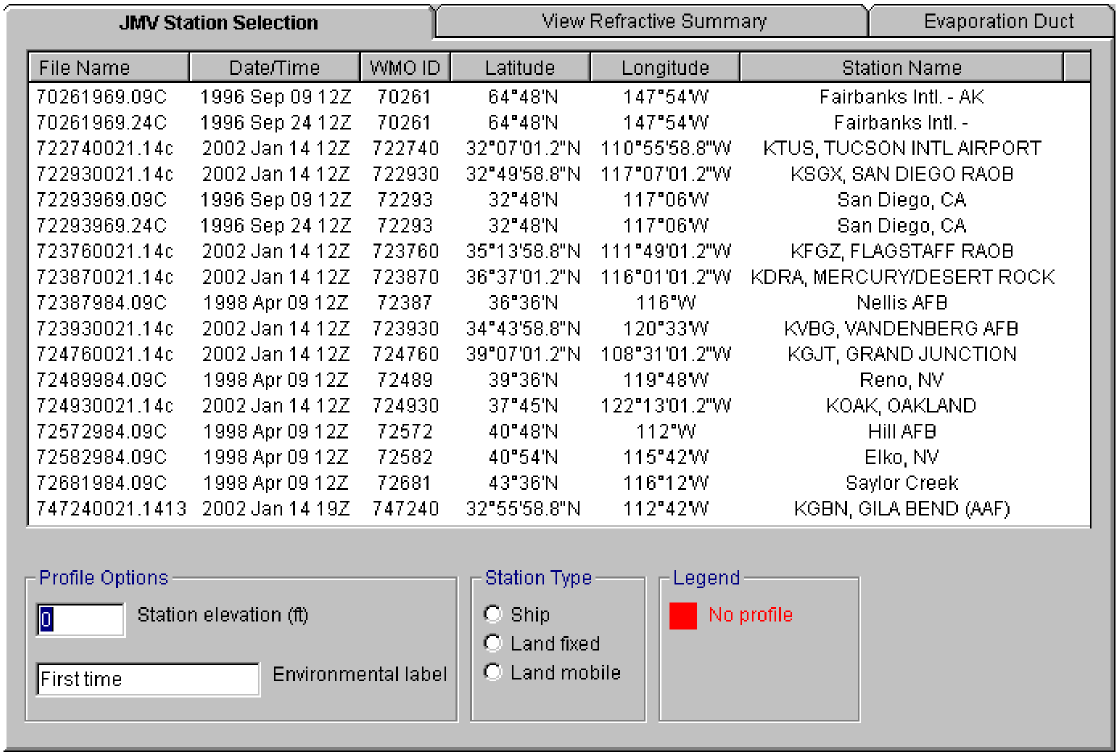
In the early nineteenth century, Marsden introduced a system for showing the distribution of meteorological data on a chart, especially over the oceans. A Macerator map projection is used; the world between 80N and 70S latitudes being divided into Marsden "squares" each of 10 degree latitude by 10 degree longitude. These squares are systematically numbered to indicate position.

Marsden square 001 has as its southeast corner, 0 degrees latitude and 0 degree longitude. The squares are then incremented in number in a westward direction until square 036, the last 0-degree latitude square. Square 037 has as its southeast corner, 10 degrees North latitude and 0 degrees longitude, and the numbering sequence is continued in the same westward to northward fashion until 80 degrees North latitude.

For the southern hemisphere, Marsden square 300 has as its northeast corner, 0 degrees latitude and 0 degrees longitude. The squares and then incremented in number in the same westward and southward fashion as are the northern latitude squares.

Joint METOC Viewer Tab

If you have the Metcast and JMV software installed, AREPS automatically reads and presents in a table format, the header identification from all upperair radiosonde files that currently exist on your hard drive. These data are displayed on the JMV tab, figure 8-22. To open this tab, click on the quick start command button.



File Name	Date/Time	WMO ID	Latitude	Longitude	Station Name
70261969.09C	1996 Sep 09 12Z	70261	64°48'N	147°54'W	Fairbanks Intl. - AK
70261969.24C	1996 Sep 24 12Z	70261	64°48'N	147°54'W	Fairbanks Intl. -
722740021.14c	2002 Jan 14 12Z	722740	32°07'01.2"N	110°55'58.8"W	KTUS, TUCSON INTL AIRPORT
722930021.14c	2002 Jan 14 12Z	722930	32°49'58.8"N	117°07'01.2"W	KSGX, SAN DIEGO RAOB
72293969.09C	1996 Sep 09 12Z	72293	32°48'N	117°06'W	San Diego, CA
72293969.24C	1996 Sep 24 12Z	72293	32°48'N	117°06'W	San Diego, CA
723760021.14c	2002 Jan 14 12Z	723760	35°13'58.8"N	111°49'01.2"W	KFGZ, FLAGSTAFF RAOB
723870021.14c	2002 Jan 14 12Z	723870	36°37'01.2"N	116°01'01.2"W	KDRA, MERCURY/DESERT ROCK
72387984.09C	1998 Apr 09 12Z	72387	36°36'N	116°W	Nellis AFB
723930021.14c	2002 Jan 14 12Z	723930	34°43'58.8"N	120°33'W	KVBG, VANDENBERG AFB
724760021.14c	2002 Jan 14 12Z	724760	39°07'01.2"N	108°31'01.2"W	KGJT, GRAND JUNCTION
72489984.09C	1998 Apr 09 12Z	72489	39°36'N	119°48'W	Reno, NV
724930021.14c	2002 Jan 14 12Z	724930	37°45'N	122°13'01.2"W	KOAK, OAKLAND
72572984.09C	1998 Apr 09 12Z	72572	40°48'N	112°W	Hill AFB
72582984.09C	1998 Apr 09 12Z	72582	40°54'N	115°42'W	Elko, NV
72681984.09C	1998 Apr 09 12Z	72681	43°36'N	116°12'W	Saylor Creek
747240021.1413	2002 Jan 14 19Z	747240	32°55'58.8"N	112°42'W	KGBN, GILA BEND (AAF)

Figure 8-22: Joint METOC viewer tab.

You must use the Metcast/JMV program external to AREPS of course to keep these files current. To create an M-unit versus height profile, simply point to and click on a file name from the table's first column. You may sort the files on any header information by clicking on any table column's header. For example, to sort the files by WMO ID, click on the WMO ID column header. The header information is not quality-controlled prior to its display. This may be seen in the strange looking station names.

JMV file format

The following is an example of a JMV version 2.1 upperair file. In order for AREPS to properly decode the file and process the data, the format of your JMV file must be identical. The first line of the file contains an identification header, a blank character, the date and time of the observation (YYMMDDHH), a blank character, and the WMO station identification number. The second line of the file contains the observing station's long name. The third line of the file is the station's location. The fourth line of the file contains column identification headers. The remaining lines of the file contain the upperair observation data. For temperature and dewpoint depression temperature both 999.9, the associated height is the station elevation in meters. Data values of 999 mean unavailable.

For pressures less than 100 hPa, the JMV file may contain the pressure rounded to the nearest hPa. Therefore for example, pressures of 8.3 and 8.0 will both be recorded as 8, or pressures of 18.7 and 18.9 will both be recorded as 19. To prevent AREPS signaling an error, (as pressures between two levels must be decreasing), AREPS will ignore all pressure levels less than 100 hPa. This will have minimal impact upon your normal propagation assessments because you are neglecting only the extremely high altitudes where anomalous propagation rarely occurs.

```
METXUAR 96092412 70261
  Fairbanks Intl. -
(LOCATION=64.8N 147.9W)
PRESS  HEIGHT  TEMP  DEPR  DD  FF
 1000     121 999.9 999.9 999 999
  998     132  -2.1   1.2 999 999
  995     156   0.4   3.2 999 999
  967     384  -0.5   4.0 999 999
  964     409  -0.5   0.0 999 999
  961     434  -0.7   4.0 999 999
  938     627  -0.9   6.0 999 999
```

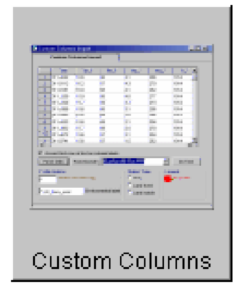
JMV error message

As the radiosonde data are read, a gross quality control check is made. Should a fatal error in the data format be detected (an increasing pressure with height for example), an error message is displayed and you will have the opportunity to view and edit the data accordingly. Once the data has been edited, you must reselect the file name to proceed.

More often than not, the METUAR (WMO upperair observation) will contain levels lacking in data. These levels have the character strings 99999, 999.9, or 999 as placeholders for the missing data. If the missing data is temperature or humidity, AREPS is not able to calculate a M-unit value for this level. Should the observation be missing needed data, you will be presented with an error window telling you of the problem. At this point you will have several options. The first option, and the one we recommend, is to open the observation file in a text editing program, evaluate the missing data, and make any changes to resolve the missing data problem. For some observations, this may be over 50% of the levels. Strictly as a convenience, your second option is to have AREPS automatically remove all the levels with missing data. Doing this may render the observation useless, however. It is always best to view the data to see how the observation will be affected by the removing these levels. Then third option is to cancel the process and select another observation.

If the missing temperature and moisture values are those of the surface level, AREPS will not remove the level but insert blank values for these missing data. From the Refractive summary tab, you may then insert appropriate values or make the conscious decision to remove the level yourself.

Custom Columns Tab



You may use the custom column tab, figure 8-23, to enter data in column formats. You may import the data from an ASCII text file, either as simple columns or tab delimited columns. To open the Custom Columns tab, click on the Custom Columns quick start command button.

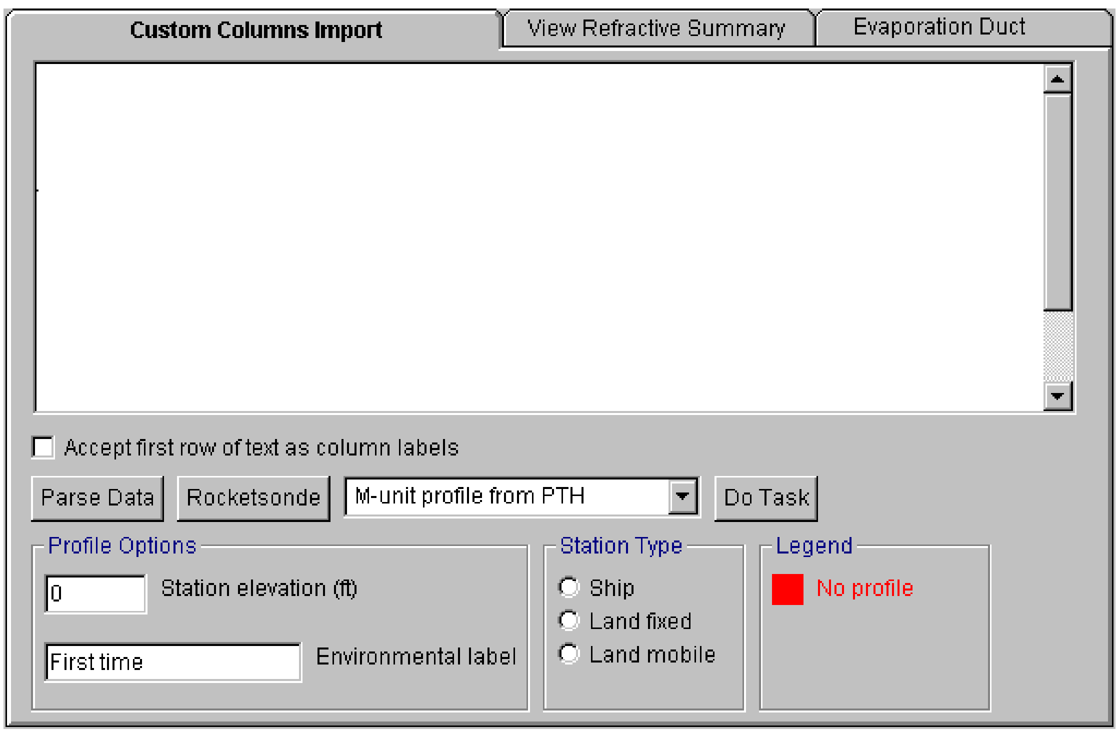


Figure 8-23: Custom columns tab.

If your current input tab is Custom Columns, the **Open tab-delimited file** item on the **File** menu will be available. If you use the Open File () toolbar icon, the program will assume simple columns.

In order to use tab-delimited columns, you must choose the option from the **File** menu. The environment program uses specialized Visual Basic code designed specifically to read tab-delimited data. If the data are not tab-delimited, the tabular form will be filled incorrectly. Therefore, you must know for sure that the file is a tab-delimited file before using this option. If you open a non-tab-delimited file by mistake, use the New Environment toolbar icon to reinitialize the window and start over again.

In addition to custom columns, you may use this tab to perform custom tasks unrelated to creating environmental input files for AREPS. To take advantage of this custom task feature, you must make specific arrangements with the technical support team.

There are several steps in using this tab. Instructions show within the help step window. The first step is to open a file or paste column text into the editing window from the Window's clipboard.

If you paste data from the clipboard, these data must include carriage return and line feed characters. In some cases, such as copying data from an Internet homepage, these characters may not be present. If these characters are not present, proper parsing will fail. To ensure proper formatting, first paste the data into a program such as Notepad, and then recopy the data from Notepad back into the clipboard.

The second step is to edit the data. Editing consists of removing all text outside of the column data. For clarity of discussion, figure 8-24 shows this text with a highlighted background. The text within your file will not have any background highlight.

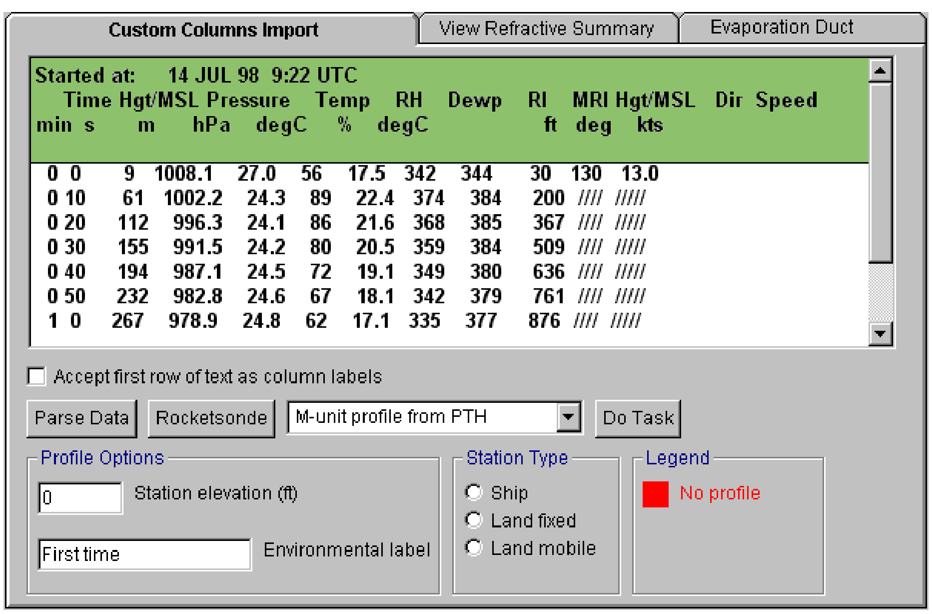


Figure 8-24: Custom columns input view.

You do not need to remove any column separator characters such as commas, etc. If the top line of text consists of column labels, you may accept these labels by checking the **Accept first row** checkbox. Please understand, by using your own labels, you must ensure they meet the units conventions used by this program.

Step three consists of parsing your columns into a tabular form control. To do this, click the **Parse Data** command button. Once parsed, the view will change to a tabular form, figure 8-25.

Step four consists of defining the column labels for the particular columns you are interested in. Right-click on each column label and select the appropriate label. You need not be concerned with all the columns if these data are not required by your task. For example, if your task is to create an *M*-unit profile from pressure, temperature, and humidity data, you need only define these three columns.

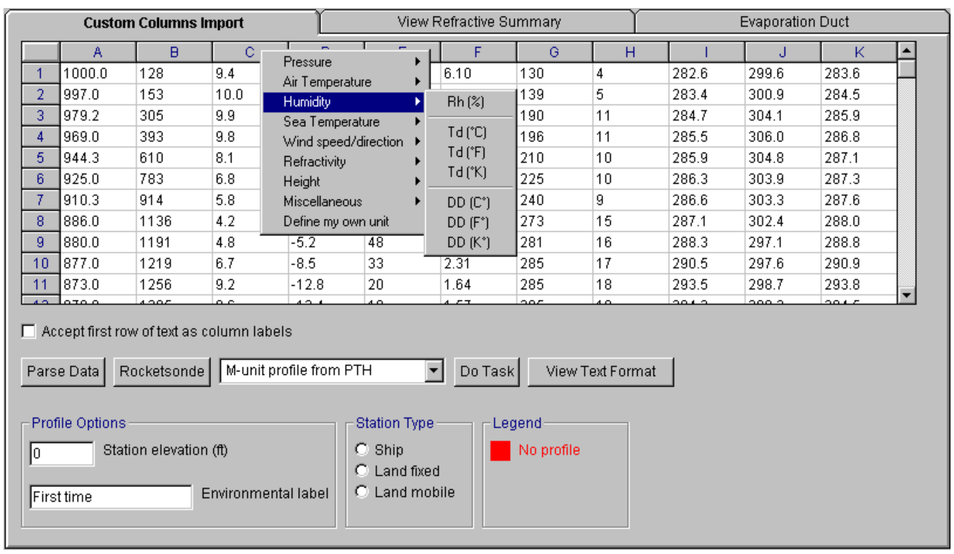


Figure 8-25: Custom columns tabular form view.

If your particular unit does not appear in the predefined menu, you may enter it by choosing Define my own units from the menu and a supplemental window, figure 8-26, will open so you may define your own units.After the columns have been defined, you may choose a task from the task dropdown menu (step 4), and then click the **Do task** command button (step 5).

Again, please contact the technical support team for a custom task designed for your particular purpose.

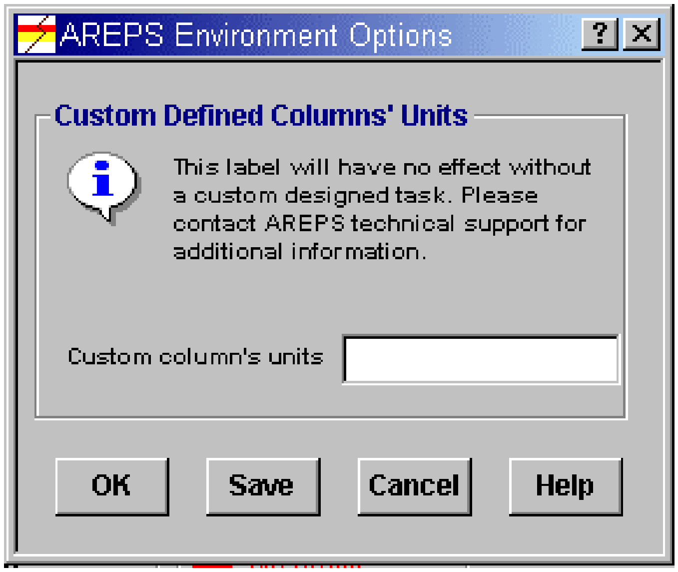
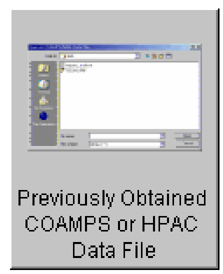


Figure 8-26: Custom columns unit definition.

Previously obtained COAMPS or HPAC data files



You may use the previously obtain COAMPS or HPAC data file window to extract environmental profiles from gridded field data files obtained externally to the AREPS program. To open this window, click on the Previously obtained data file quick start command button.

The AREPS geographical area tab, figure 8-27, is used both by this previously obtained COAMPS or HPAC data file method and the TEDS COAMPS query method. The only difference between the two methods is how the controls are populated. In the case of the TEDS COAMPS query method, the controls are populated automatically from the data file download from TEDS. In the Previously obtained COAMPS or HPAC data file method, you must specify which data file to use. You will be asked for the file name before this tab becomes visible.

The left side of the AREPS geographical area tab shows the COAMPS data file description in addition to a Tau dropdown menu containing all the various data taus in the file. Start by selecting a Tau from the dropdown menu. When you do this, the data are read and the NW/SE geographical area boundaries are displayed. Additionally, the latitude and longitude input fields become available.

The next step is to enter the AREPS project geographical area information. This information should coincide with your AREPS project.

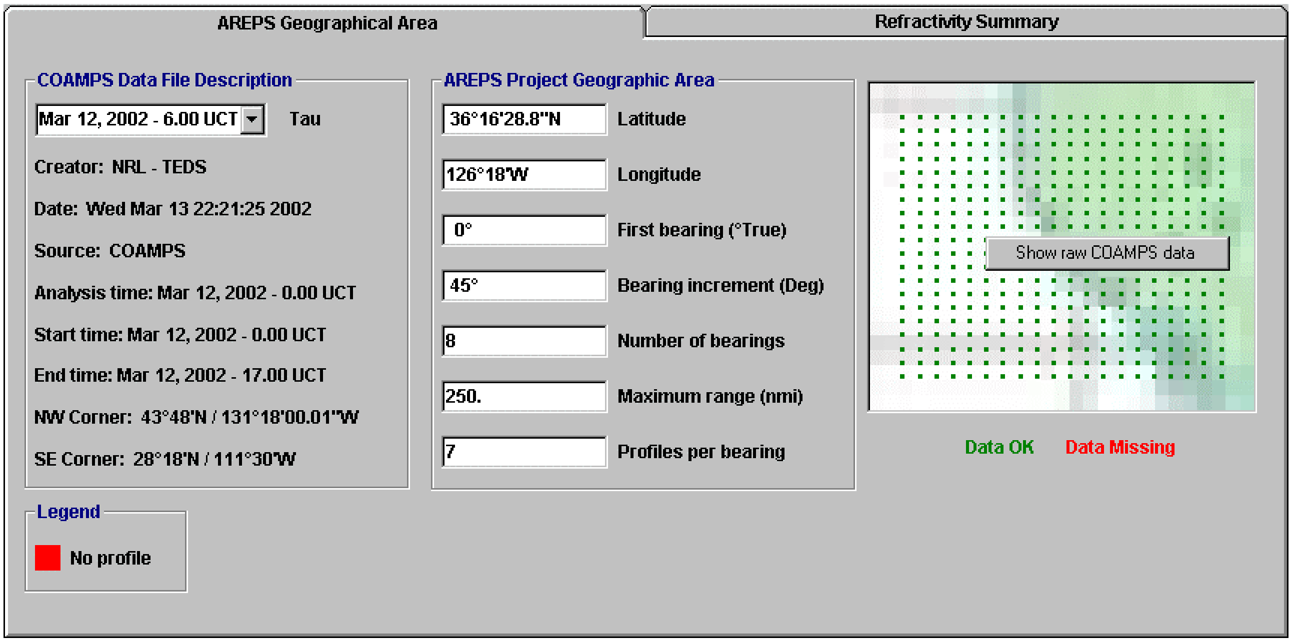


Figure 8-27: AREPS geographical area tab.

For AREPS 3.0, if an environment is not specified along a project bearing, the closest bearing will be used. In addition, the latitude and longitude of the environment's center will be checked against the latitude and longitude of the project. If the center is more than 50 kilometers away, you will receive an error message and the project will not execute. You must insure your project and your range and bearing dependent environment coincide.

Now, click the Execute ( ) toolbar button or choose **Extract AREPS environment** from the **Run** menu. The data will be processed and the refractivity profiles will be created. At this point, the legend will say Profile OK and you may save ( ) the profiles as an atmospheric environment file.

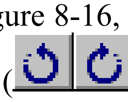
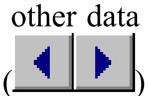
Profiles per bearing

You may specify how many vertical profiles of modified refractivity you want along each extraction bearing. The number you choose will be divided into the maximum range to get the range of each profile from your center latitude and longitude. When the data is extracted along a bearing, the profile constructed will start from a four-point interpolation of the raw COAMPS state variables (pressure, temperature, and humidity) and the M-units versus height will be calculated from state variables.

Tau

Tau is the forecast time of the COAMPS data. The forecast time is nominally 48 h (72 for European Area). The COMAPS model runs in a continuous update cycle, with the first-guess fields come from the previous COAMPS forecast. The update cycle is usually every 3 hours.

Refractivity Summary

This second tab of this input method is the refractivity summary tab where you may view the profile information. This is the same summary tab, figure 8-16, as used by all the other data input methods. You may use the rotate in bearing () and step in/out () in range toolbar buttons to see each individual profile.

View COAMPS coverage

To the right of the extraction tab is a map with the grid of COAMPS data points, as illustrated in figure 8-28. Grid points with valid data are colored green and grid points with invalid data are colored red. It also shows the bearing lines you have defined on the AREPS geographical area tab. By right clicking on one of the COAMPS data points drawn on the map, the data are displayed in a popup window.

As a convienecе, you may left-click on this map and the latitude and longitude under the mouse pointer will be used to fill the latitude and longitude input fields.

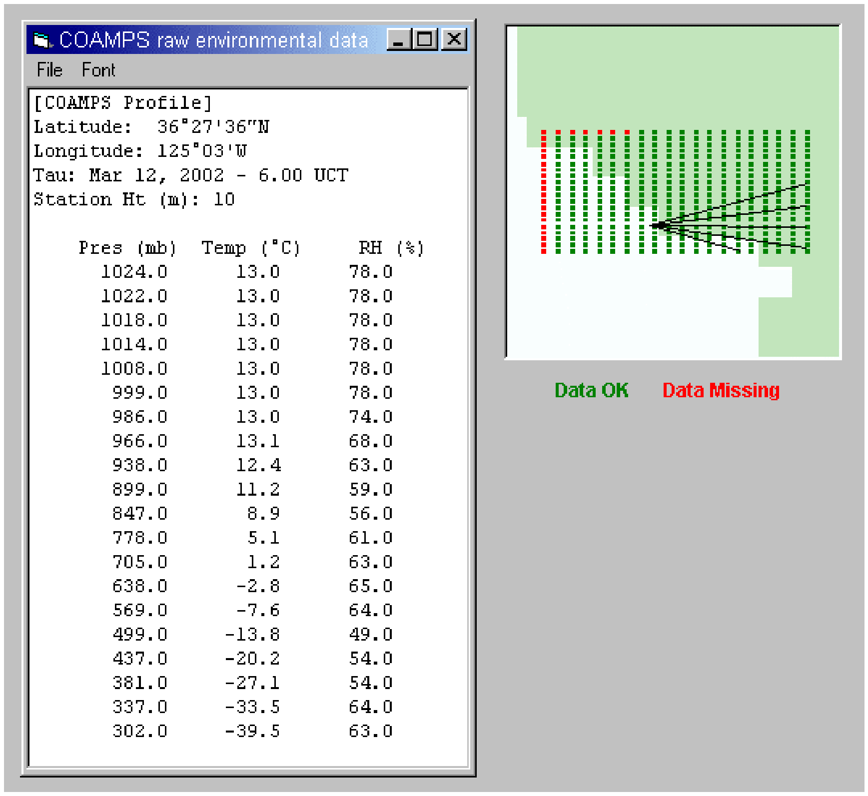
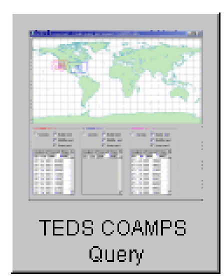


Figure 8-28: View COAMPS coverage tab.

TEDS COAMPS query window



In order to use this input method, you must meet the requirements for TEDS access. To start this input method, click on the TEDS COAMPS Query quick start command button.

When the TEDS COAMPS query window opens, figure 8-29, the world map is clear of any colored boxes and the COAMPS area tabular forms are empty.

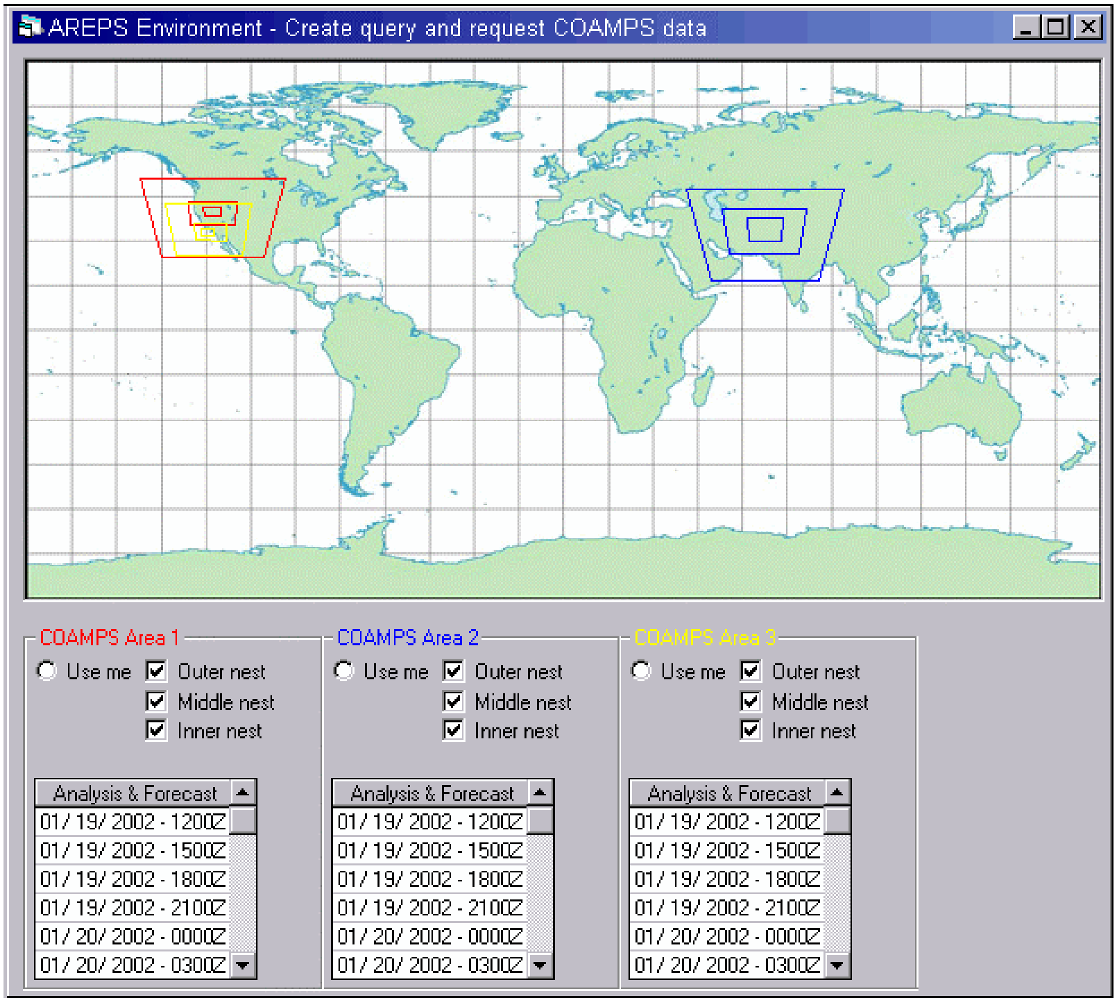
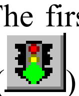
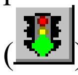


Figure 8-29: View COAMPS coverage tab.

The first step is to search TEDS for existing COAMPS data. Simply click the Execute () toolbar button or choose **Search for COAMPS areas** from the **Run** menu. The connection to TEDS will be made and a search will start. The progress of the search appears in a popup status window, figure 8-30.

If the search was successful, status window will close and the COAMPS areas and nests will be drawn on the map in colors associated with the COAMPS area tabular form frames. If the search was unsuccessful, the status window will remain open with an explanation of the failure and possible solutions. The text of the status window may be saved to an ASCII text file that you may email to technical support.

To obtain the COAMPS data, simple click the Use Me option button of the desired area, and then click the Execute () toolbar button or choose **Download COAMPS data** from the **Run** menu. Again, a popup status window will open, showing you the progress of the data download. Once all the data is obtained, this query window will automatically close and the data extraction window, figure 8-27, will open so you may define your refractivity profile requirements, view the resulting profile data, or view the raw COAMPS data.

TEDS query status window

When using the TEDS COAMPS query method, any communications with TEDS will be reflected in a popup status window. (The status window is not used for the TEDS single station observation method. The status of this method shows in the right panel of the main window's status bar.)

The status text will reflect connection dialogues, execution of software code routines, data download progress, and success or error messages. In some cases, the text will be very cryptic in nature as the messages are designed for software debugging aids. Across the bottom of the status window is a status bar showing the current time and the total time of connection.

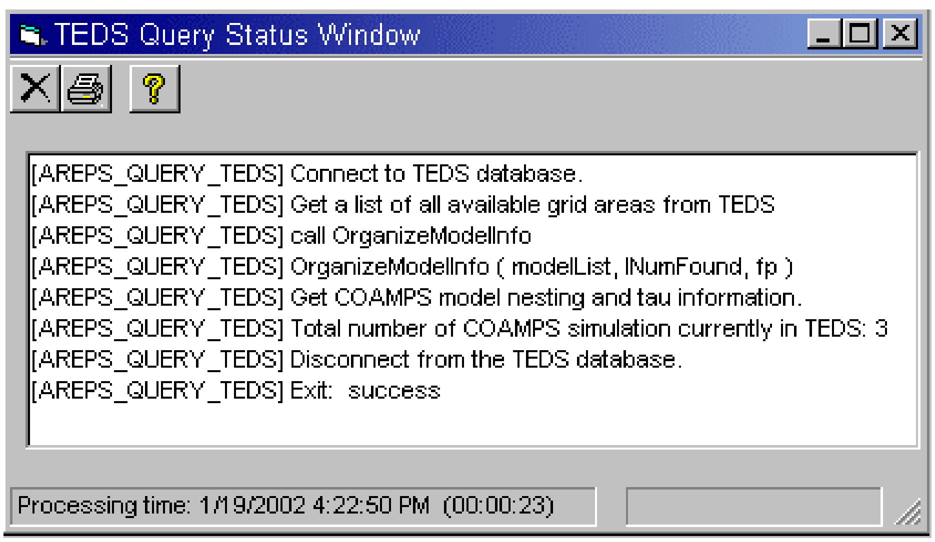
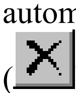


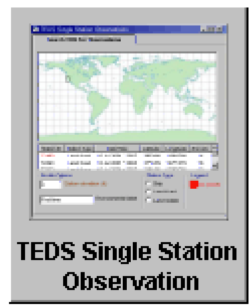
Figure 8-30: TEDS query status window.

The status window will open automatically anytime there is an attempt to communicate with TEDS. If the process completes successfully, the status window will automatically close. You may stop the process at any time by clicking on the Cancel () toolbar button.

If the process is unsuccessful, an error window will open telling you there was an error and providing additional information. Simply click the **OK** button to close the error window. The status window will remain open however, so you may review the messages. The text of the status window may be saved to an ASCII text file that you may email to technical support. You must close the status window yourself by clicking on the **Cancel** button or the standard Windows Close button.

Some data download processes may take a very long time depending upon your network connection speed and the amount of data you requested. To obtain an entire COAMPS area via the Internet, 20 minutes in not extraordinary.

TEDS single station observation



In order to use this input method, you must meet the requirements for TEDS access. To start this input method, click on the TEDS Single Station Observation quick start command button. Doing so will open the search TEDS for observations window, figure 8-31.

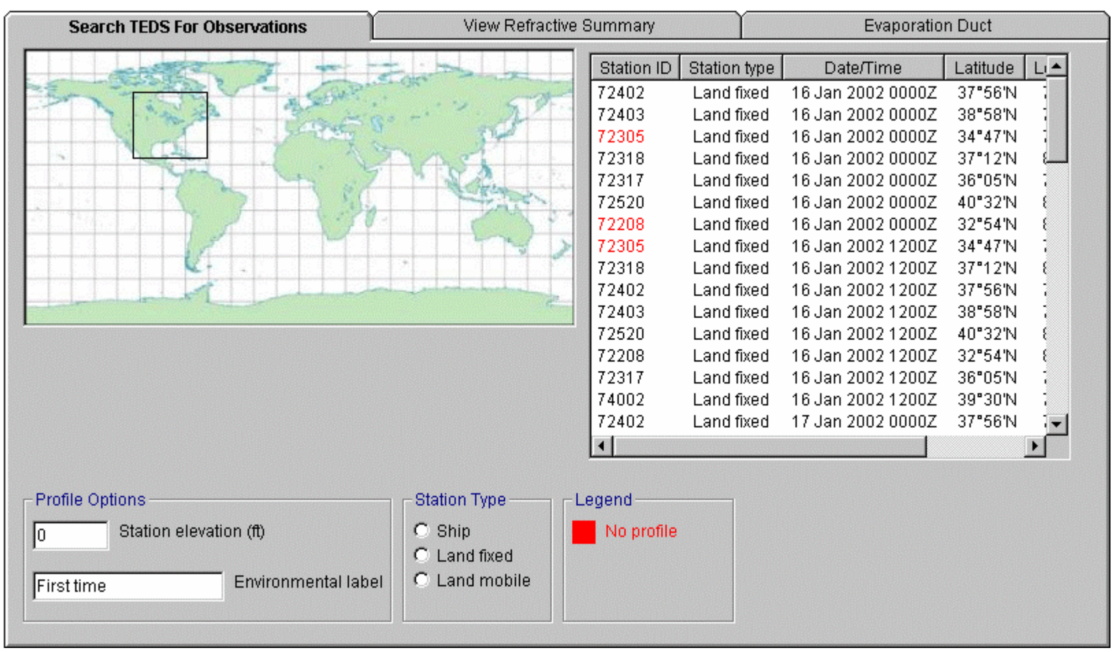
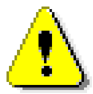


Figure 8-31: Search TEDS for observations tab.

To retrieve data from TEDS, you must define a search location. Left clicking on the world map will open a rubberband box that may be moved and sized by dragging the mouse. When the rubberband box encompasses your area requirement, click the **Execute** toolbar button or choose **Search TEDS for observations** from the **Run** menu. TEDS will be accessed and all observations within the defined area will be displayed in the station table. The status of the process shows in the right panel of the main window's status bar.

You may then click on the desired Station ID from the table and the environment program will create the AREPS environment file.



There are several problems with the MALLT software. First, once you have clicked the Execute toolbar button, the MALLT takes over control of the program. Because of the MALLT construction, it is not possible to have a Cancel command button capability. You will have to wait for the MALLT to "time-out" on it's own before you can continue using the environmental program. The "time-out" may be several minutes. Secondly, selecting too large a geographical search area will cause the MALLT to return a "no observations found" error. If this should happen, reduce the size of the search area and try again.

As the data are retrieved, some quality control checking is performed. Should an observation contain potential errors, its station id number will be colored red (as shown in figure 8-31). If you selected this station, you will receive an additional warning notification. At this point you may proceed to the refractive summary tab to view the data and possibly edit them, or you may simply select another station. The environmental program will not save a profile until all errors have been resolved.

Environmental File Format

Atmosphere files created by the environment program are saved in the environment folder. The file's name will be whatever you give it with an env_.txt extension. This file is an ASCII text file that may be opened a viewed with any text editor. We recommend you do not change any values within the file, external to AREPS.

The format of the file is the same as that used by Microsoft in their initialization files. There are sections identified by name inside square brackets [] and within each section, there is a variable name, an equals sign, a data value, and optionally, a comment proceeded by the # sign. It is not necessary to have a value for every variable name. However, certain variables are required and if they are missing from the file, an error message will be generated. The section identifiers are *Area*, *Bearing*, and *Profile*. For a single profile file, there need not be an Area and Bearing section. All the *Profile* sections apply to the previous *Bearing* section until the *Bearing* section is changed. There may be an unlimited number of bearings and profiles.

Within the *Profile* section, the levels are defined as level = aaa.a bbb.b cccc.c dd.d ee.e and gradient where aaa.a is height in whatever height units, bbb.b is M-units, and if from an environmental observation, ccc.c is pressure in millibars, dd.d is air temperature in degrees Celsius, and ee.e is relative humidity in percent, and gradient is a text description of the refractive gradient for the layer. AREPS only uses the height and M-unit values and ignores all other entries should they exist in the file. The other values are there for record completeness should you want to know what the height and M-units are calculated from.

Below is a sample of an atmosphere file. As you can imagine, the file could be very large depending upon the number of bearings within you area and the number of profiles per bearing.

```
[AREPS Environment]          # envAREPS  August 27 2002 13:31:50

[Environment Area]
BearingInc         = 45
Bearings           = 8
DateTime           = "Aug 27, 2002 - 0.00 UCT"
FirstBearing       = 0
HeightUnits        = "m"
LatCenter          = 34.1110555555556
LatMax             = 0
LatMin             = 0
LonCenter          = -119.222361111111
LonMax             = 0
LonMin             = 0
MaxRange           = 463
NumLats            = 0
NumLons            = 0
Profiles           = 0
ProfilesPerBearing = 7
RangeUnits         = "km"

[Environment Bearing]
Bearing  = "  0 "
MaxRange = 0 "km"
Profiles = 8

[Environment Profile]
Datetime         = "Aug 27, 2002 - 0.00 UCT"
HeightUnits      = "m"
Latitude         = " 34°06'39.80''N"
Longitude        = "119°13'20.50''W"
RangeFromCenter  = 0
Bearing          = "  0°00'00.00''T"
RangeUnits       = "km"
StationHeight    = 184.2034
StationName      = ""
WMOStationID     = ""
MUnitsType       = "m-unit"
ObservationType  = "COAMPS data"
SurfaceAirTemp   = 21.84331
SfcAirTempUnits  = "°C"
AbsoluteHumidity = 12.42163
EvapDuctHt       = "0.0"

LevelTable       = 20                    # Number of levels
```

```
#      Height    Munits  Pressure   Temp(C)  Humidity     Layer
        0.000   341.960   # Extrapolated using first layer's gradient
      184.203   362.070   990.478    21.843    64.396    Normal
      201.723   363.982   988.478    21.843    64.120    Normal
      227.101   366.978   985.588    21.871    63.844    Normal
      262.353   370.821   981.588    21.871    63.279    Normal
      310.480   374.970   976.153    21.899    61.458    Normal
      384.899   381.032   967.808    21.948    58.313     Super
      496.999   389.476   955.373    22.075    52.855     Super
      666.575   402.788   936.870    22.267    45.129     Super
      919.657   422.617   909.931    22.677    33.553    Normal
     1265.001   450.730   874.427    22.900    19.241    Normal
     1760.959   502.090   825.709    21.368     7.399    Normal
     2460.183   596.991   761.101    18.141     8.792    Normal
     3256.927   707.683   692.659    12.707    12.545    Normal
     4050.406   817.189   629.485     7.351    14.944    Normal
     4942.270   940.932   564.043     0.994    16.944    Normal
     5939.120  1080.626   497.325    -6.657    18.454    Normal
     6938.848  1222.445   436.717   -14.391    21.013    Normal
     7927.358  1363.705   382.599   -21.695    21.172    Normal
     8796.658  1489.143   339.495   -27.981    25.166    Normal
     9545.838  1597.495   305.556   -32.585    23.766
```

HPAC File Format

The Hazard Prediction and Assessment Capability (HPAC) automated software system provides the means to accurately predict the effects of hazardous material releases into the atmosphere and its impact on civilian and military populations. The system uses integrated source terms, high-resolution weather forecasts and particulate transport analyses to model hazard areas produced by military or terrorist incidents and industrial accidents.

One method of obtaining high-resolution weather data is via communications with various Navy Meteorology and Oceanography (METOC) centers. Data is transmitted via an ASCII text file. This file is referred to as a HPAC file by AREPS. AREPS is able to read and process these data.

Should you have access to high-resolution data that you would like AREPS to read, please contact technical support.

The HPAC file contains a header section and then a grid of data points section. The header section provides information about the creator of the file, the mesoscale model used to create the environmental data, the time of the weather forecasts, and the format of the data points section. The format of the header section is:

```
# CREATOR: NRL - TEDS
# DATE: Mon Jul 01 09:31:38 2002
# SOURCE: COAMPS
# TYPE: FORECAST
# ANALYSIS: 2002 7 1 0.00
# START: 2002 7 1 0.00
# END: 2002 7 2 0.00
# TIMEREFERENCE: UTC
# MODE: PROFILE ALL 0
PROFILE    1
Z       WDIR    WSPD    P       T       HUMID
M       DEG     M/S     MB      C       %
-9999
```

where the lines

```
Z       WDIR    WSPD    P       T       HUMID
M       DEG     M/S     MB      C       %
```

indicate the first column of the data point section is height in meters, the second column is wind direction in degrees, the third column is wind speed in meters per second, the fourth column is pressure in millibars, the fifth column is air temperature in degrees Celsius, and the sixth column is relative humidity in percent.

The format of the data point section is arranged on a rectangular grid where the first data point location corresponds to the south-west corner of the rectangular grid. Successive data point locations step northward in latitude until the north-west corner of the grid is reached. Then there is an eastward step in longitude with the latitude returning to the southern boundary of the grid. This northward and then eastward stepping is repeated until the final data point location at the north-east corner of the rectangular grid is reached.

Each data point location is preceded with an ID line. The format of this ID line is:

```
ID: 34 020701 0.00 -141.90 41.73  0.00 288.65 -9999
```

where the first number of the ID line is the number of the datapoint location. (The south-west corner of the rectangular grid would be data point number 1). The second number is the data in YYMMDD format. The third number is the time in coordinated universal time. The fourth number is the longitude of the datapoint location with negative numbers representing west longitudes and positive numbers representing east longitudes. The fifth number is the latitude of the data point location with negative numbers representing south latitudes and positive numbers representing north latitudes. The sixth number is the ground elevation (referenced to mean sea level) in meters. The seventh number is the sea-surface temperature in Kelvin degrees. –9999 is used as a placeholder for land locations. The final number is a placeholder for a terrain description. This version of AREPS does not use the sea-surface temperature or the terrain description. Below the ID line are the columns of data formatted as described above. An example for say, data points 34 and 35 location is:

```
ID: 34 020701 0.00 -141.90   41.73  0.00 288.65 -9999
      10       254       4.0     1026     11.9        69
      30       253       4.1     1024     11.9        69
      55       253       4.2     1021     11.9        69
      90       253       4.4     1017     11.9        69
     140       253       4.6     1011     11.9        69
     215       252       4.8     1002     11.9        70
     330       252       5.1      988     11.9        66
     500       253       5.6      968     12.0        59
     750       254       6.3      940     11.6        50
    1100       255       7.1      901     10.6        42
    1600       257       8.2      848      9.2        32
    2300       261      10.5      779      7.0        29
    3100       264      13.3      707      4.0        24
    3900       264      17.0      640      0.6        28
    4800       264      21.1      572     -3.4        36
    5800       264      25.8      503     -8.9        51
    6800       262      28.3      442    -14.2        56
    7800       261      30.3      386    -21.2        64
    8675       259      31.3      343    -27.9        66
    9425       258      32.1      308    -33.6        46
```

```
ID:  35 020701 0.00 -141.90  42.63   0.00 287.93 -9999
       10       251       4.9     1026     11.4        67
       30       251       5.0     1024     11.4        67
       55       250       5.2     1021     11.4        67
       90       250       5.4     1016     11.4        67
      140       250       5.6     1010     11.4        67
      215       250       6.0     1001     11.4        67
      330       251       6.3      988     11.4        64
      500       252       6.7      968     11.5        58
      750       253       7.3      939     10.9        53
     1100       254       8.1      900      9.6        46
     1600       255       9.0      848      8.1        34
     2300       259      11.4      778      5.8        33
     3100       262      14.3      705      2.6        32
     3900       263      18.1      639     -0.9        36
     4800       263      22.4      570     -5.0        43
     5800       263      27.2      501    -10.1        54
     6800       260      31.4      440    -15.1        63
     7800       259      34.7      385    -21.8        77
     8675       259      35.9      341    -28.1        72
     9425       260      36.9      307    -34.2        54
```

thus, for data point 34, the height of the first pressure level is 10 meters above the surface elevation (which for this example is 0 meters), the wind direction is 254 degrees True, the wind speed is 4 meters per second, the pressure is 1026 millibars, the air temperature is 11.9 degrees Celsius, and the relative humidity is 69 percent.

TERRAIN

As the default, AREPS uses digital terrain elevation data from the National Imagery and Mapping Agency (NIMA). The normal distribution of DTED data is via CD-ROMs. In addition to DTED terrain data, AREPS is capable of using terrain data you specify yourself. You may use the terrain window to enter your own data and save it in a format usable by AREPS. Since these terrain data are stored in and read from an ASCII text file, you may also choose to create your own terrain data file externally to the AREPS program using an ASCII text editor such as Notepad. Be sure to follow the specifications of an AREPS terrain file when making your own file in this fashion.

AREPS allows for a number of options in the consideration and management of the terrain data. For a detailed discussion of these options, refer to chapter 7 (Options).

National Imagery and Mapping Agency

NIMA maintains a general help desk that serves as a primary entry point for questions about products or services and as the primary customer advocate. The general help desk is available 24 hours a day. The general help desk address is:

NIMA General Help Desk (L-52)
3200 South Second Street
St. Louis, MO 63118-3399

Contact telephone numbers are:
DSN 490-1236
Toll free 1-800-455-0899
Commercial (314) 260-1236
Fax (314) 260-1128
DSN fax 490-1128

Digital Terrain Elevation Data

NIMA provides their DTED data in level 0, level 1, and level 2 formats. Level 0 spacing is 30 arc seconds in horizontal resolution (approximately 1 kilometer). DTED level 0 data is unlimited distribution and may be obtained directly from NIMA's public Internet homepage. DTED level 1 spacing is 3 arc seconds in horizontal resolution (approximately 100 meters). Level 2 post spacing is 1 arc seconds in horizontal resolution (approximately 30 meters). Level 1 and 2 data are limited distribution. For this reason, DTED data are not and may not be distributed with AREPS. If you have a connection to the Secure Internet Protocol Router Network (SIPRNET), you may download the DTED level 1 and 2 data directly from NIMA's SIPRNET homepage. In addition, NIMA provides terrain data in other formats such as raster graphics. AREPS will accept DTED level 0, 1, and 2 coverage. You may choose your DTED level by selecting the **DTED Terrain** item from the **Options** menu.

DTED Folder Structure

When AREPS uses DTED data from a CD-ROM, they are copied to the hard disk in the same folder structure as on the CD-ROM itself, as illustrated in figure 9-1. Should you obtain your DTED data by downloading from the NIMA Internet or SIPRNET homepages, it is important you recognize this folder structure as you will need to reproduce it yourself and copy your downloaded data into it. Under the DTED folder are subfolders named E003, E004, W114, etc. (note 3 digits), where the W and E represent west and east and the 003, 004, and 114 represent the whole degrees of longitude. Within each of these subfolders, the file naming convention is N32.DTX, S15.DTX, etc., where the N and S represent north and south and the 32 and 15 represent whole degrees of latitude. The file extension of .DTX represents the DTED level, where .DT0 is level 0 data, .DT1 is level 1 data, and .DT2 is level 2 data. Though experience however, we have learned this file extension convention is not always followed. Thus, AREPS will read the internal file header information to determine the correct DTED level.

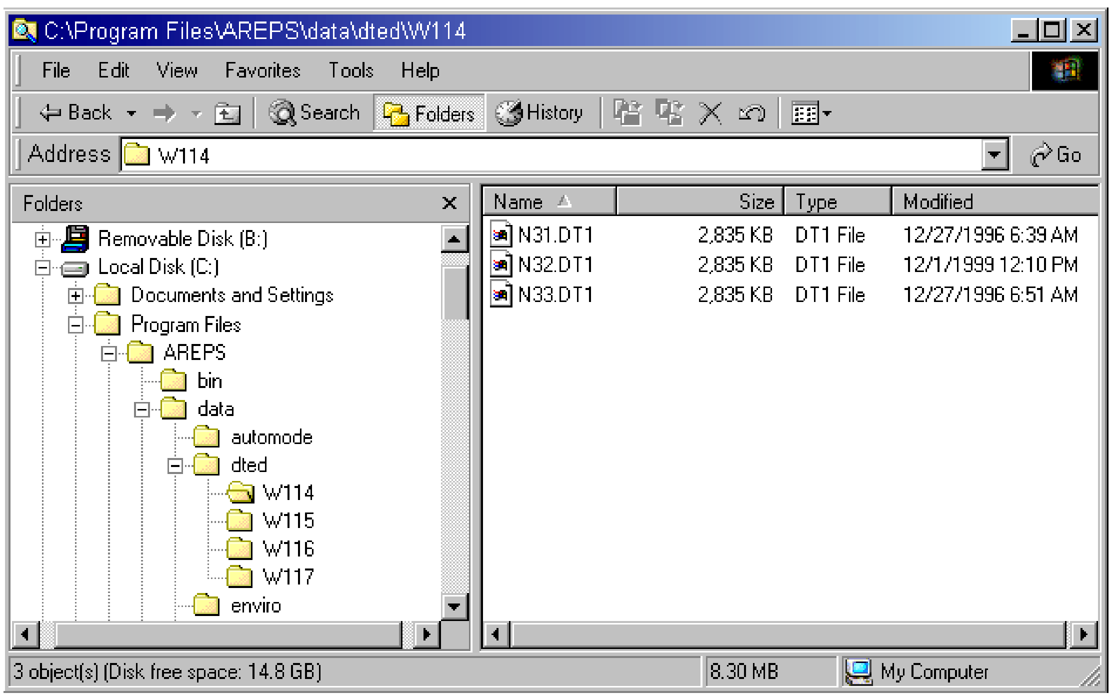


Figure 9-1: DTED folder structure.

DTED Manager Window

When AREPS needs DTED data, it will first look in the primary folder. If the data are not found, it will then look in the secondary folder. If the data are still not found, it will look at the CD-ROM. When no data are found in any location, the program will open the DTED manager window and ask you for the necessary DTED CD-ROM.

The DTED manager, figure 9-2, consists of a menu system, several command buttons, a world map showing the distribution of DTED CDs, a listing of DTED and other CD information, and some directional and informational text.

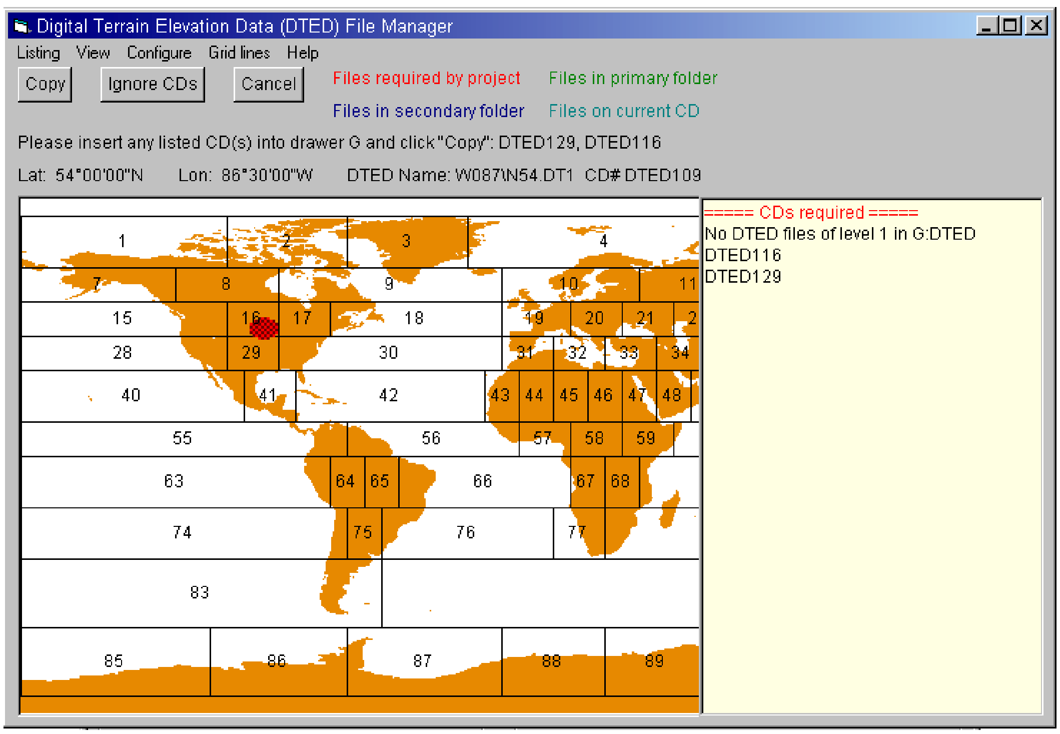


Figure 9-2: DTED manager window.

If the CD drive contains a necessary CD-ROM when the manager window opens, the Copy action starts automatically. If not, the list box will show you the numbers of the DTED CD-ROMs you need to provide. Simply place any of these CDs into the CD drive (in any order) and then click the **Copy** button. The manager will copy the needed files to your hard drive, placing them in the primary DTED folder. Repeat the process for all CDs. You may also click the **Ignore CDs** command button to continue with your project without using DTED data, or you may click the **Cancel** command button to return to the project window.

DTED manager - world map

The world map of the manager shows a number of items, all of which may be turned on or off from the View menu. By default, when the manager opens, the world map will show you the grid of DTED CD-ROMs as produced by NIMA. This grid will also show the number of each CD-ROM.

Using the color coding of the legend, the DTED files needed for your project will show on the map. In figure 9-2, the needed CDs are numbers 116 and 129, and cover a section of the central United States.

DTED manager – list box

The manager listing contains information selected from the Listing menu. By default, when the manager first opens, the listing contains the numbers of the DTED CDs required for your project. As additional information is selected from the listing menu, it is added to the list box. Scroll bars are added to the list box as required.

In the example of figure 9-3, the list box shows the required CDs and those DTED files currently in the secondary DTED folder.

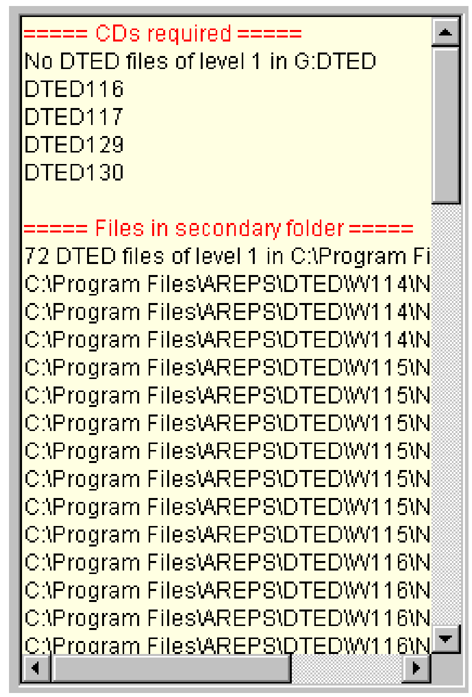


Figure 9-3: DTED manager list box.

DTED manager - listing menu

The listing menu, figure 9-4, contains a number of different types of information that may be shown in the list box. As items are selected from the menu, the information is added to that currently in the list box.

The first five menu items allow you to list the CDs required by your project, the actual DTED file names required by your project, the DTED files currently residing in the primary DTED folder, the DTED files currently residing in the secondary folder, and the DTED files upon the CD currently in the CD drive.

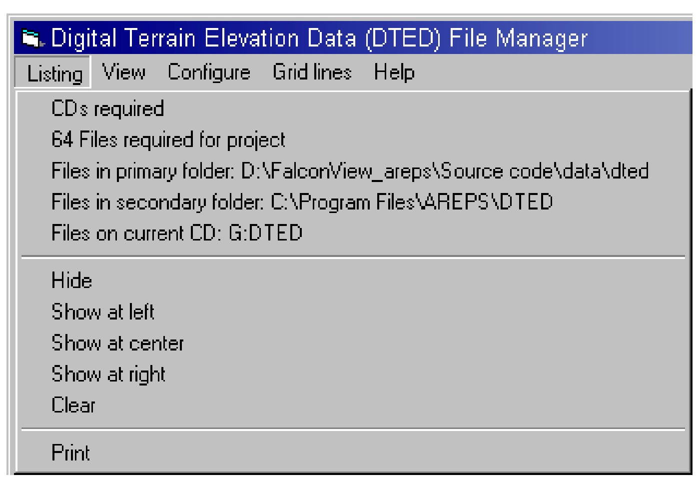


Figure 9-4: DTED manager listing menu.

The menu items below the separator bar allow you to position the list box at various places within the window. The print menu item will print the current contents of the list box.

DTED manager - view menu

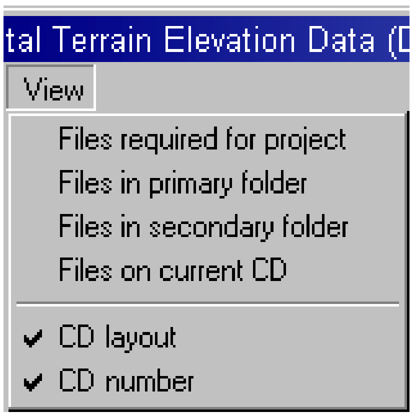


Figure 9-5: DTED manager view menu.

The View menu, figure 9-5, allows you to show or remove various pieces of information upon or from the world map picture.

By default, the required files for your project, the NIMA CD**Error! Bookmark not defined.** layout, and the CD numbers are shown.

DTED manager – configure menu

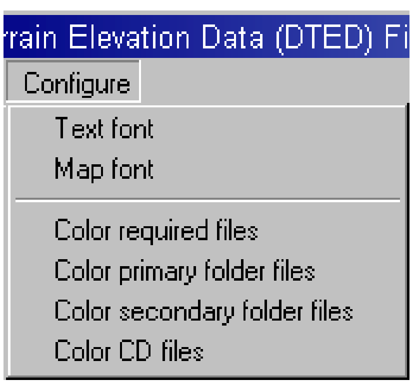


Figure 9-6: DTED manager configure menu.

The Configure menu, figure 9-6, allows you to change the fonts of the text that shows in the list box and upon the map. In addition, you may change any of the legend colors.

DTED manager – grid lines menu

The Grid lines menu, figure 9-7, allows you to display a 10 by 10, 30 by 30, or 45 by 45-degree grid upon the world map. You may use the View menu to hide the CD layout lines and CD numbers in order to decrease the confusion of lines and text.

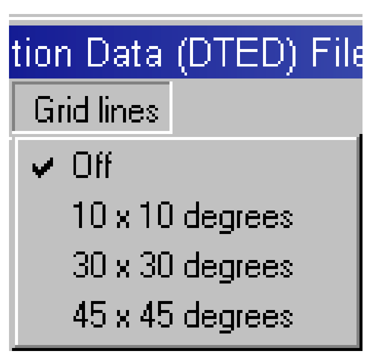


Figure 9-7: DTED manager grid lines menu.

Custom Terrain Window

In addition to DTED terrain data, AREPS is capable of using terrain data you specify yourself. You may use the custom terrain window, figure 9-8, to enter your own terrain data and save them in a format usable by AREPS. Selecting the Custom Terrain item from the Environment menu opens the custom terrain window.

You may also use this window to edit a terrain file created from DTED data. Since these terrain data are stored in and read from an ASCII text file, you may also choose to create your own terrain data file external to the AREPS program using an ASCII text editor such as Notepad. Be sure to follow the specifications of an AREPS terrain file when making you own file in this fashion.

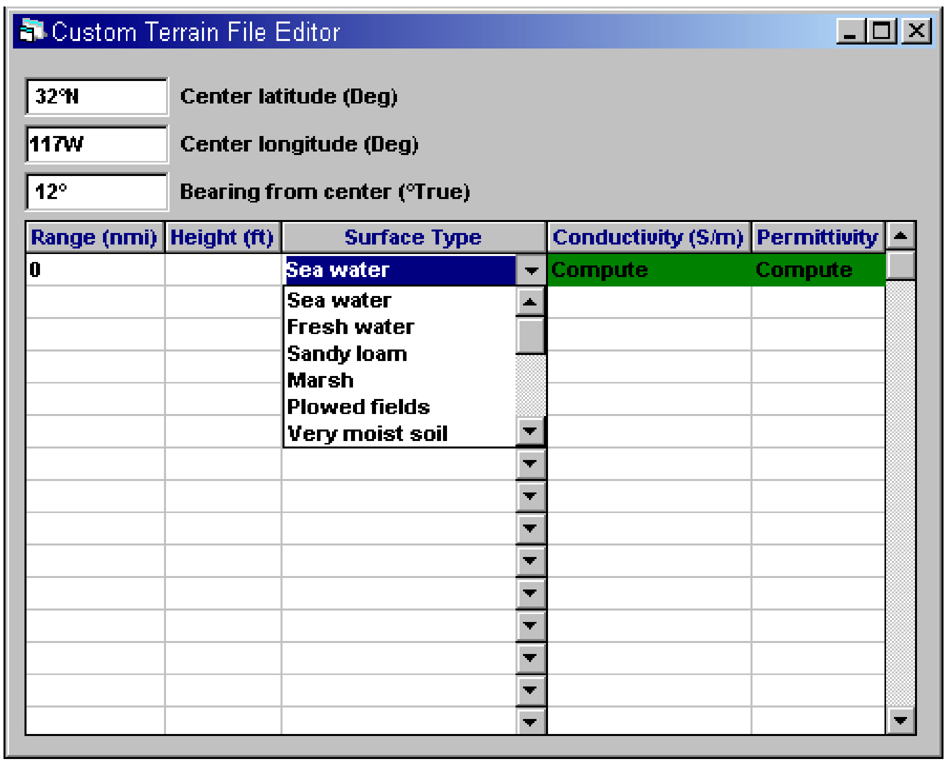


Figure 9-8: Custom terrain window.

Center Location

The center terrain location is the latitude and longitude of the first terrain point. The values may be entered in degrees, minutes, and/or seconds. The format may be decimal numbers or integer numbers separated by a space. For example, if you enter 36.5 and then press the Enter key or leave the input box, the field will change to 36°30'. You may also enter a decimal value for degrees, minutes, and seconds. For example, if you enter 32.5 degrees 16.3 minutes, and 17.5 seconds, the field will change to 32°46’36". In addition, you must specify a quadrant indicator for the latitude and longitude. This is N for north, S for south, E for east, and W for west. By default, if you don’t enter a quadrant, north and east are assumed. This default quadrant may be changed from the **Program flow** item of the **Option** menu.

Bearing from Center

The bearing is the azimuth along which the terrain height data applies. The bearing is in whole degrees relative to true north.

The bearing is in whole degrees relative to true north. The value may be entered in degrees, minutes, and/or seconds. The format may be decimal numbers or integer numbers separated by a space. For example, if you enter 36.5 and then press the **Enter** key or leave the input box, the field will change to 36°30’. You may also enter a decimal value for degrees, minutes, and seconds. For example, if you enter 32.5 degrees 16.3 minutes, and 17.5 seconds, the field will change to 32°46’36".

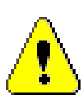
AREPS 3.0 allows you to specify your own terrain along a single bearing. If you have requested more than one bearing and are also using your own terrain, you will receive a warning notice, the number of bearings will be automatically set to one, and the project will continue.

Terrain Range and Height

The first column of the terrain tabular form contains range values. The values must be increasing in range. The units of range may be feet, yards, meters, nautical miles, statute miles, kilometers, and kiloyards. To change the units of the column, right click on the column label. The value of the first range must be zero.

The second column of the terrain tabular form contains height values. The units of height may be feet or meters. To change the units of the column, right click on the column label.

Surface Type



Before you continue, for frequencies above 100 MHz, please understand that surface types have minimal influence upon propagation, and for the vast majority of cases, you need not be concerned with a surface type. In addition, AREPS assumes a perfect conducting surface for horizontally polarized antennas and any specified surface type is ignored.

Should you be concerned about surface types for vertically polarized antennas, however, AREPS uses the surface conditions as defined by the International Telecommunication Union, International Radio Consultative Committee (CCIR). These conditions are broken into seven categories based upon surface characteristics. For your convenience, we have provided plain language descriptors that fall within the seven categories. These descriptors are given in table 9-1.

Table 9-1: Surface type descriptors.

Sea water	Fresh water	Sandy loam	Marsh
Plowed fields	Very moist soil	Medium dry ground	Sandy soil
Rocky soil	Medium sized towns	Very dry ground	Granite mountains
Industrial areas	New ice	Old ice	Self-defined

You may select one of these descriptors from the surface type dropdown menu of column three. Based upon the surface descriptor you have selected and the frequency of the project's transmitter, a proper calculation of surface conductivity and permittivity is made.

If you select one of the plain language descriptors, the permittivity and conductivity columns of the tabular form will be filled with the word **Compute**, the background color of these columns will change to green, and you will not have access to these columns. If you select **Self-defined** from the menu, you must specifically enter a surface permittivity and conductivity value.

A surface type must be associated with the first range. If you are using DTED terrain data and the terrain elevation at the first range is zero, seawater is assumed for the entire path, even if nonzero terrain elevations are subsequently encountered. If the elevation at the first range is not zero, medium dry ground is assumed for the entire path, even if zero elevations are subsequently encountered. Please understand this assumption is made because no data exists on the DTED CD-ROM to say what the surface type is for any elevation.

If you are using DTED data and don't want this assumption, you must specify the surface type yourself.

▶ **To specify a surface type with DTED data.**

Steps	Comment
1	Execute the project to have AREPS read the DTED data and create the terrain files. By default, terrain files are not saved. You must choose to save them by selecting the **Save Terrain in ASCII text format** item from the **Save Optional Data item** on the **Options** menu.
2	After the terrain files are created for all project bearings, open each file individually in the terrain window, select a different surface type for the first (and any other) range, then save the file.
3	Re-execute the project.

Surface Electrical Characteristics

The fourth and fifth columns of the terrain tabular form contain the surface electrical characteristics expressed as permittivity and conductivity.

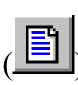
The electrical characteristics of any medium may be expressed by three parameters. The first parameter is the permeability, the rate of diffusion of a substance such as a gas or water through a porous material. The second parameter is the permittivity, the ratio of the electric flux density produced by an electric field in a medium to that produced in a vacuum by the same field. The third parameter is the conductivity, a measure of how a particular substance conducts electricity. They jointly influence wave propagation. The permeability of the ground can normally be regarded as equal to free-space permeability so for most propagation considerations, we are only concerned with permittivity and conductivity.

The effective values of the constants of the ground are determined by the nature of the soil, by the soil's moisture content and temperature, by the frequency, by the general geological structure of the ground, and by the effective depth of penetration and lateral spread of the waves. While it has been established by numerous measurements that the values of the electrical characteristics vary with the nature of the soil, it is probable that the variation may be due not so much by the chemical composition of the soil as its ability to absorb and retain moisture. The moisture content of a particular soil may, however, vary considerably from one site to another, due to differences in the general geological formations that provide better drainage.

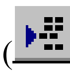
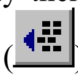
Typical values of conductivity and permittivity for different ground types are generally determined by laboratory measurements of a particular homogeneous soil type. In nature, however, the surface and sub-surface are rarely homogeneous, but rather consist of two or more layers of different thickness and different conductivity and permittivity. AREPS considers only values for a homogeneous surface.

Open and save terrain data

The **Open/Remove Terrain File** item of the Environment menu, allows you to open a terrain file for editing. The Windows Explorer window opens allowing you to browse your entire folder structure for the desired file. The terrain file may be one you previously created yourself or it may be a file created by AREPS while reading data from a DTED CD-ROM. In this way, you may add surface conditions to DTED data should the information be available.

The **Save ASCII** button () on the main toolbar, saves the data from the terrain tabular form into an ASCII text file readable by AREPS. The file will be saved in the terrain folder with the extension ter_.txt.

Insert and delete terrain range

From the AREPS main toolbar, the **Insert row** toolbar button () allows you to open a blank range input point prior to the current cursor location. You may then enter a new range, height, and surface condition. The **Remove row** toolbar button () removes the range at the current cursor location. As ranges are inserted and deleted, proper input limits show in the status bar's left panel.

Terrain file names

Terrain files are created in three ways and the naming conventions and storage locations are slightly different for each.

1. You may create your own file (or edit a DTED CD-ROM file) in the Custom Terrain File Editor window. You may name the file as you choose using any valid Windows file name character including spaces. If you have installed AREPS as being a DII-CEO compliant application, the additional DII-COE file name conventions will apply. There is no default name. AREPS will append the ter_.txt extension onto the file name you specify if it doesn't already have a .txt extension. For example, if you specify the file name as MyTerrain, the file name will be MyTerrain_ter.txt.

2. You may desire access to the DTED terrain data for use in your own evaluation program. Rather than creating a program yourself to read the DTED CD-ROMs, you may have AREPS save the terrain's height and range data (one file for each project bearing) in the project's folder as an optional ASCII text file. By default, the file name is Terrain_ddd_mm_ss.txt where the ddd represents the bearing in degrees, mm in minutes, and ss in seconds relative to true north.

3. You may create your own terrain file external to the AREPS program. When doing this, be sure to follow the proper file conventions. Of course, you may name the file as you choose using any valid Windows file name character including spaces. AREPS will not modify your file's name.

Terrain data in ASCII text format

The format of the terrain file is the same as that used by Microsoft in their initialization files. There are sections identified by name inside square brackets [] and within each section, there is a variable name, an equals sign, a data value, and optionally, a comment proceeded by the # sign. It is not necessary to have a value for every variable name. However, certain variables are required and if they are missing from the file, an error message will be generated.

An example of the terrain file format follows.

```
[AREPS Terrain]          # Areps30  March 29 2002 15:03:35

[Terrain center]
Latitude       = " 33°N"   # Center latitude
Longitude      = "118°W"   # Center longitude
Bearing        = " 90°T"   # Bearing from center
RangeUnits     = "m"       # Range units for terrain points
HeightUnits    = "m"       # Height units for terrain points
GroundRangeUnits = "m"     # Range units for ground points


[Ground data]
# 0 GroundData :Type, Range(m), Permittivity, Conductivity
#
[Terrain]
# 2779 Terrain points : Range(m) Ht(m)
Terrain(0)     =    0,   30
Terrain(1)     =  100,   20
Terrain(2)     =  200,   40
Terrain(3)     =  300,   45
Terrain(4)     =  400,   48
Terrain(5)     =  500,   75
Terrain(6)     =  600,  102
Terrain(7)     =  700,  154
Terrain(8)     =  800,   86
Terrain(9)     =  900,   72
Terrain(10)    = 1000,   92
Terrain(11)    = 1100,   98
Terrain(12)    = 1200,  123
Terrain(13)    = 1300,  147
Terrain(14)    = 1400,  139
Terrain(15)    = 1500,  126
Terrain(16)                   =      1600,            142
```

DECISION AIDS

AREPS displays a number of tactical decision aids. These are radar probability of detection, Electronic Support Measure (ESM) vulnerability, UHF-VHF communications, and simultaneous radar detection and ESM vulnerability, and a surface-search range bargraph display. The display types for these decision aids may be probability of detection, propagation loss, propagation factor, or signal-to-noise ratios. Any aid with a threshold value may also be displayed in a display type versus range or display type versus height format.

Coverage Display Window

Coverage decision aids of radar detection, ESM intercept, or communications are shown in the display window as illustrated in figure 10-1. Various other information is displayed on the right side of the decision aid.

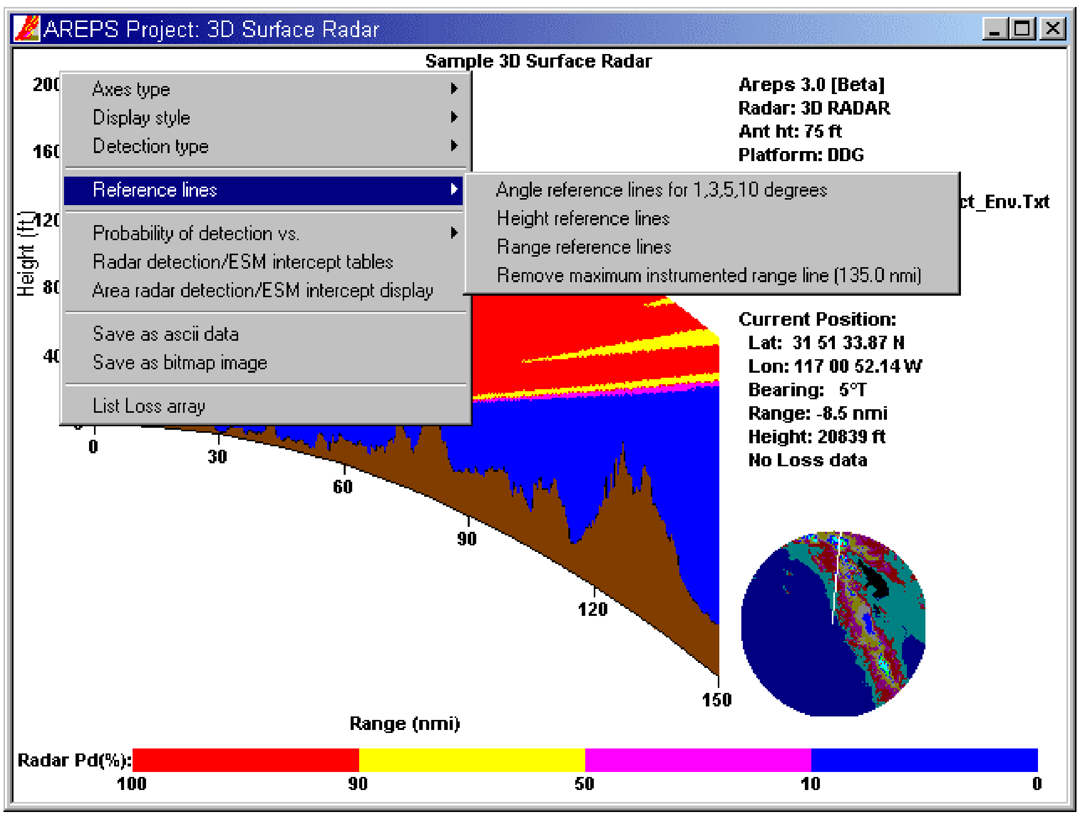
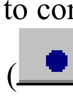
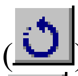
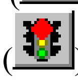


Figure 10-1: Coverage display window.

Some of this information is project dependent such as radar name, target name, environment file name, etc. Other information shows as the mouse cursor is moved about the display. Such information is height, range, latitude, longitude, bearing, propagation loss, etc. By right mouse clicking anywhere within the display, a popup options menu (shown opened) opens. From this menu you may select other decision aids, change display parameters, list or view project data, or perform other functions.

In order to calculate propagation loss in the extended optics region, a loss at the top of the parabolic equation region is needed for all ranges. Thus, the extended optics region is calculated after the decision aid has reached its final range. You will notice this "two pass" calculation as a blank area in the upper right corner of the decision aid. Once the extended optics calculations are made, the total image of the decision aid is shown.

Display Window Toolbar

The AREPS main toolbar provides functions to control the azimuth display. With these buttons you may pause () or continue () the rotation of the azimuth display, single step through the decision aids either counter-clockwise () or clockwise () in bearing, print () a single aid, or stop and close () the display.

Display window popup menus

Right clicking anywhere within a coverage display will open a popup menu, as shown in figure 10-1, from which you can choose many other options and displays. These include axis options, display options, detection options, height and range displays, fonts and colors, and listings of many parameters such as project options, system database parameters, etc. Refer to chapter 7, Options, for a complete discussion of each of these options and displays.

The type of detection you have chosen will serve as the text for the height and range displays. For example, if you have selected propagation loss as your detection type, the text of the height and range menu item will say Propagation loss vs..

The list variables menu is available when AREPS is operating in its debug mode, otherwise this menu item will not be visible.

Display window color legend

For coverage decision aids, beneath the diagram is a color bar legend for the type of data being displayed. For radar only displays, the colors represent probabilities of detection (in percent), propagation loss (in dB), propagation factor (in dB), or signal-to-noise ratios (in dB) depending upon the display parameter you choose from the project options menu. You may choose the limits, the interval, and the number of intervals. Figure 10-2 illustrates the color legend for radar probability of detection.

Figure 10-2: Radar probability of detection color bar.

For Both radar and ESM displays, the colors represent the display intervals as described above but in a line just below the color bar, there is text indicating a binary (yes or no) ESM intercept. The binary decision point is shown by an up-arrow as shown in figure 10-3.

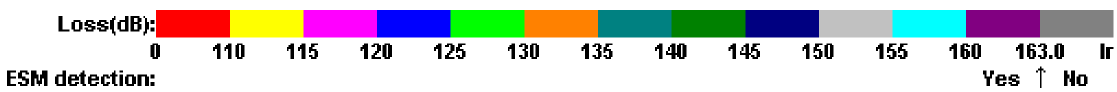


Figure 10-3: Radar and ESM color bar.

For the ESM only and Communications displays, the colors represent ESM intercept or communications, yes or no, on a dB scale. The binary decision point is shown by an up-arrow as shown in figure 10-4.

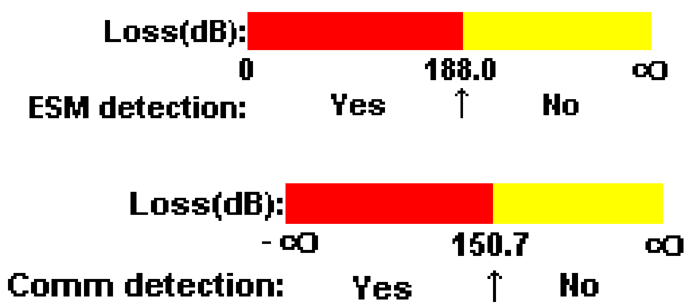


Figure 10-4: ESM and communications color bar.

Display window color legend

If you have chosen to use DTED data with your project, a DTED map display, figure 10-5, appears in the lower right corner of the decision aid. The map shows the 360-degree terrain height coverage centered on the project's latitude and longitude with a radius of the project's maximum display range. Superimposed on the map is a white bearing line showing the current bearing of the display. By moving the mouse pointer over this map, height and

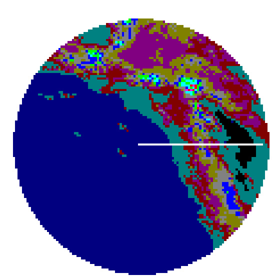


Figure 10-5: DTED map

other information is shown on the right side of the decision aid. For the initial release of AREPS 3.0, only the 360-degree (circular) map is available. Future versions of AREPS will provide other features for this map.

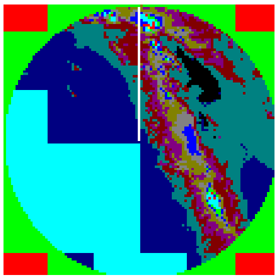


Figure 10-6: DTED map

If AREPS is running in its Debug mode or if certain DTED files are missing, the terrain map may have a different look as illustrated in figure 10-6. The colors indicate different file conditions. As you move the mouse cursor over the map, these conditions are shown in the right panel of the status bar. Using figure 10-6 as an example, the red squares indicate missing DTED files. The green squares represent DTED files within the square latitude/longitude boundary of the project's maximum range but outside of the bearing sweep range, and the cyan color represents DTED files that contain no data, that is, assumed to be water.

Display Parameter Versus-Range or Height Display Window

Rather than a height versus range coverage display, the display parameters of propagation loss, probability of detection, propagation factor, or signal-to-noise ratio may be shown in a decibel versus range or height, figures 10-7 and 10-8 respectively.

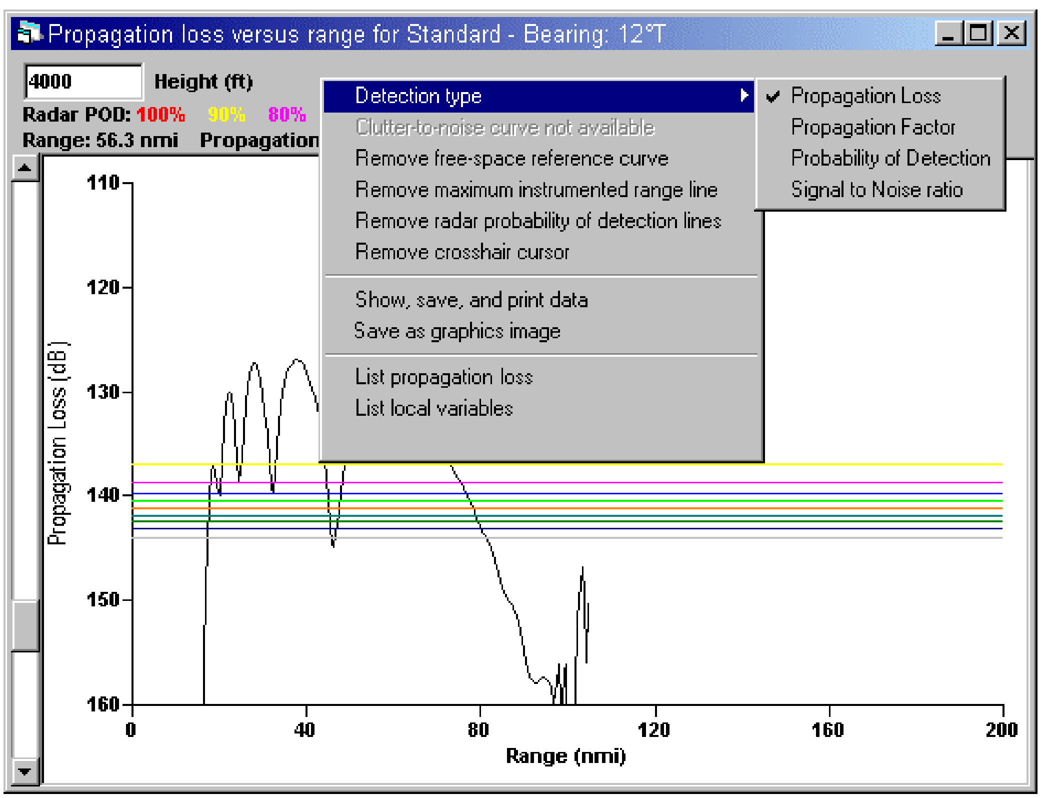


Figure 10-7: Propagation loss versus range display.

While the instantaneous display is for a constant range/ height, you may use the scroll bar at the left/bottom edge of the display to change the range/height or you may enter an exact value into the input field at the top left corner of the window.

As the mouse cursor moves over the display, a crosshair follows along the curve. The range and display values, both at the mouse cursor position and at the crosshair position, are shown. The initial range/height value is selected from the coverage display by right mouse clicking on the coverage display window at a particular height. Right click anywhere on the display to activate an options popup menu (shown below). From the popup menu, you may display a free-space reference curve, display the radar maximum instrumented range line, display/save/print the data from a data display window, and turn off/on the cursor.

If this window is a signal-to-noise display, you may also choose to show the clutter-to-noise curve.

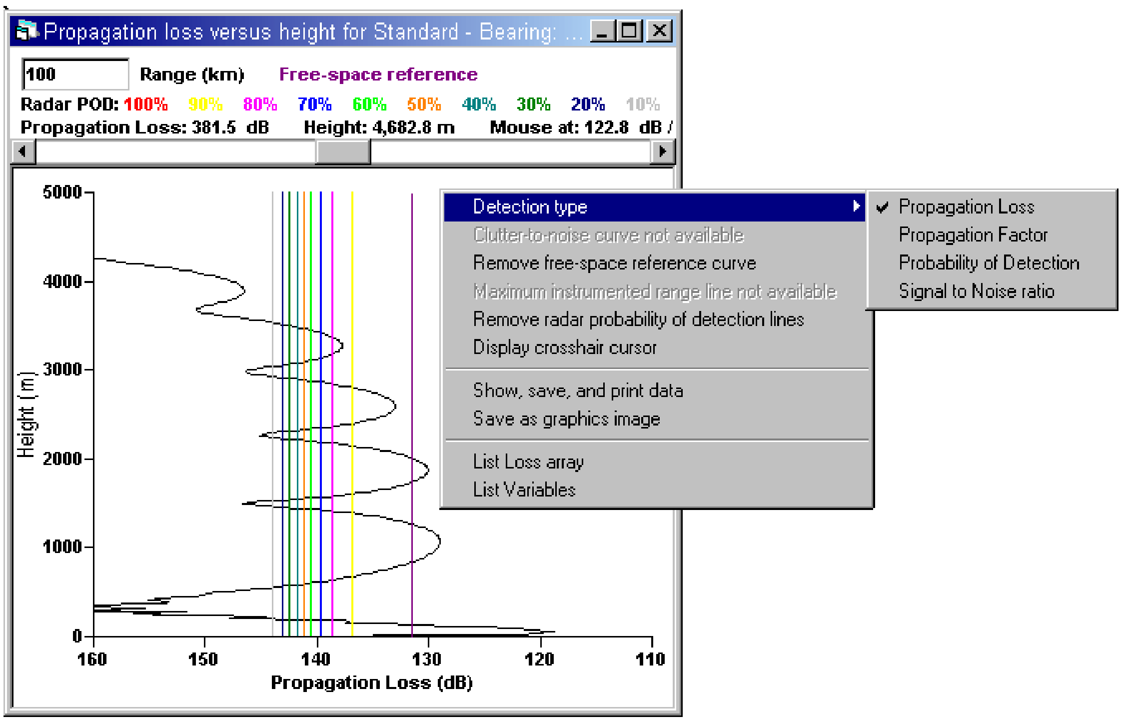


Figure 10-8: Propagation loss versus height display.

List loss array window

There may be times you wish to see all the actual propagation loss values calculated by APM. You do this by using the list loss array window. This window, figure 10-9, is opened from right-click popup menus for the various decision aids windows.

The list loss array window shows a multi-row/column grid of propagation loss values in centibels. Each row represents a height and it's particular graphic pixel location. In the example of figure 10-9, the first row contains data for a height of 5000 meters and these data are associated with the 384th vertical pixel on the coverage display (the top left-hand corner of the display). Each column represents a range and its particular pixel location. In the example below, the first column contains data for a range of 0.45 kilometers and these data are associated with the 1st horizontal pixel on the coverage display (the bottom left-hand corner of the display).

By using the Save menu item, you may save these data to an ASCII text file. This file is different from the file you get when you Save APM as ASCII text file. Only the propagation loss data are saved in this file. In the latter file method, the propagation loss data together with all the other data necessary to recreate the file are saved.

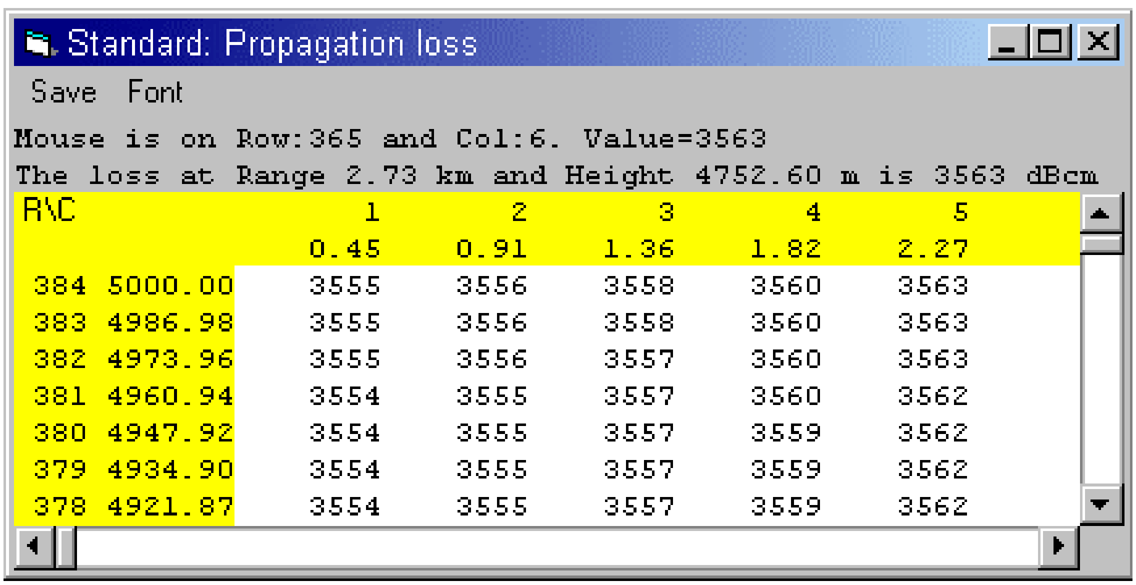


Figure 10-9: List loss array window.

Surface-search Range Tables

We have developed a surface-search radar-detection-range model. The effects of radar cross-section variability as a function of viewing angle, ship displacement, ship height, and range are combined with the APM capabilities of range-dependent environments and terrain to produce a bar-graph display of detection for six classes of targets, figure 10-10. These classes range from a periscope to a very large warship (aircraft carrier). The viewing angle variability is displayed as sub-bars within each ship class. These angles are labeled minimum, maximum, and average corresponding to a view of bow, beam, and quarter.

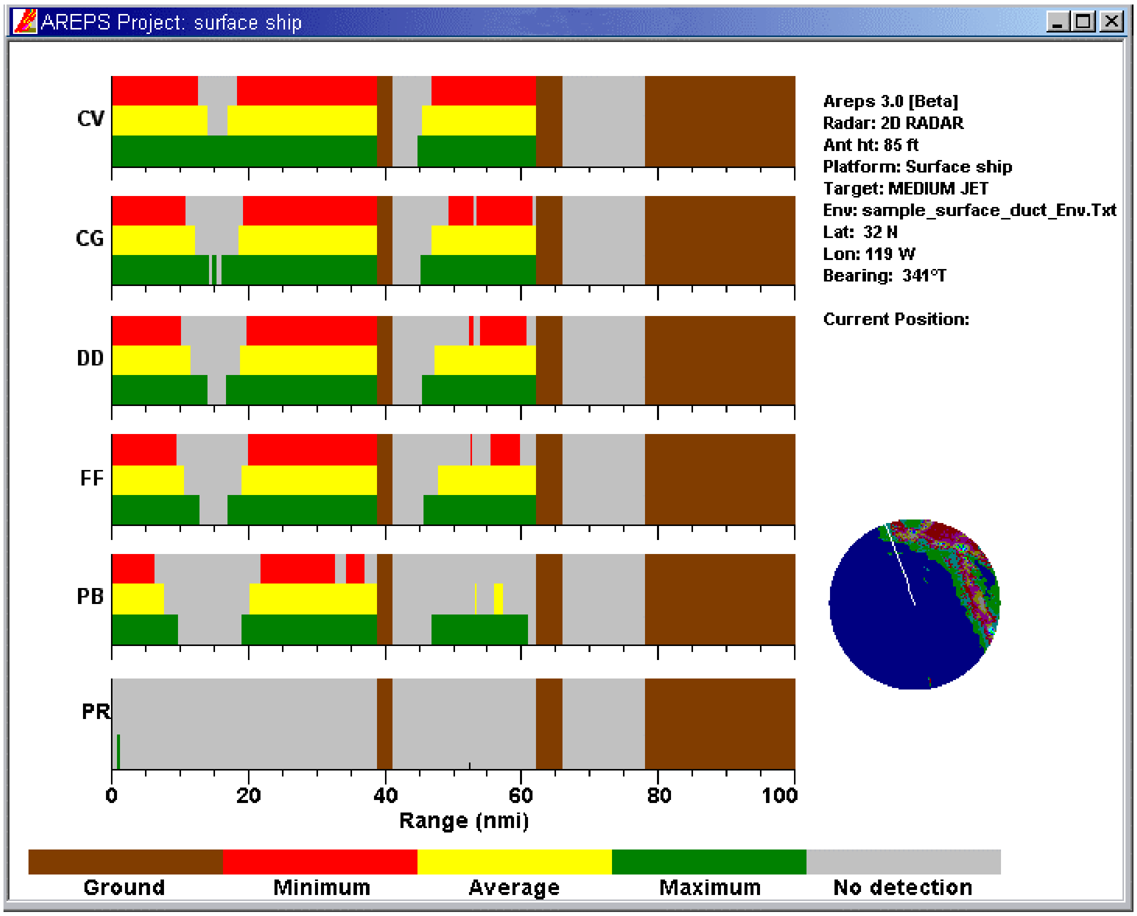


Figure 10-10: Surface-search range table decision aid.

In the implementation of the model, we decided not to terminate the calculations at the first range where the terrain is encountered. This allows for showing detection beyond islands where surface-based ducting skip zones may allow for extended propagation. As a consequence of this decision, the display will also show detection over terrain should the height of the terrain be sea level. Of course this is unrealistic, as ships would never be located over terrain.

For this reason, it is important to observe the small terrain map display to resolve any ambiguity questions.

Figure 10-11 is a coverage display corresponding to the same geographical location and bearing as the surface-search range table of figure 10-10. This picture provides an intuitive feeling for skip-zone breaks in detection as well as propagation over an island. Of course, the target of the coverage display does not correspond to any of the six target classes of figure 10-8.

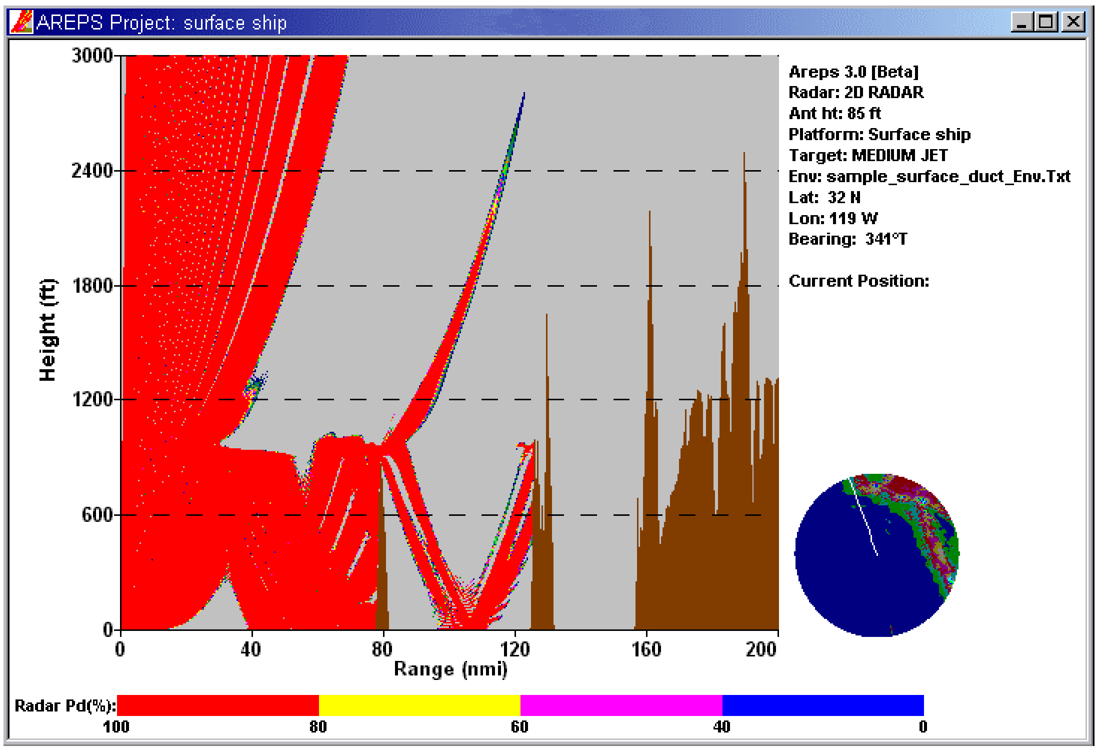


Figure 10-11: Coverage diagram showing surface-based ducting.

Maximum Range Tables

By right clicking anywhere within the coverage display graphic, you many select the maximum range tables from the menu.

The decision aid, figure 10-12, consists of a table with 5 columns, the first being height (from the minimum to the maximum display height). The other 4 columns depend upon the type of decision aid you chose for your project. By default, the second column contains the project's target, ESM receiver, or communications receiver. If the project is both a radar detection and ESM decision aid, the first column will contain the project's target and the 5th column will contain the project's ESM receiver. The other columns are variable. Within each cell of the table, a MAXIMUM detection range associated with the particular height and target, ESM receiver, or communications receiver is displayed. You may change any of the heights, choose a different target, ESM receiver, or communications receiver from the dropdown menu in the first row of each column, or change the probability of detection from the dropdown menu. You may also enter any probability of detection number directly without selecting one from the menu. You may right-click on the table or the labels to obtain additional information or options.

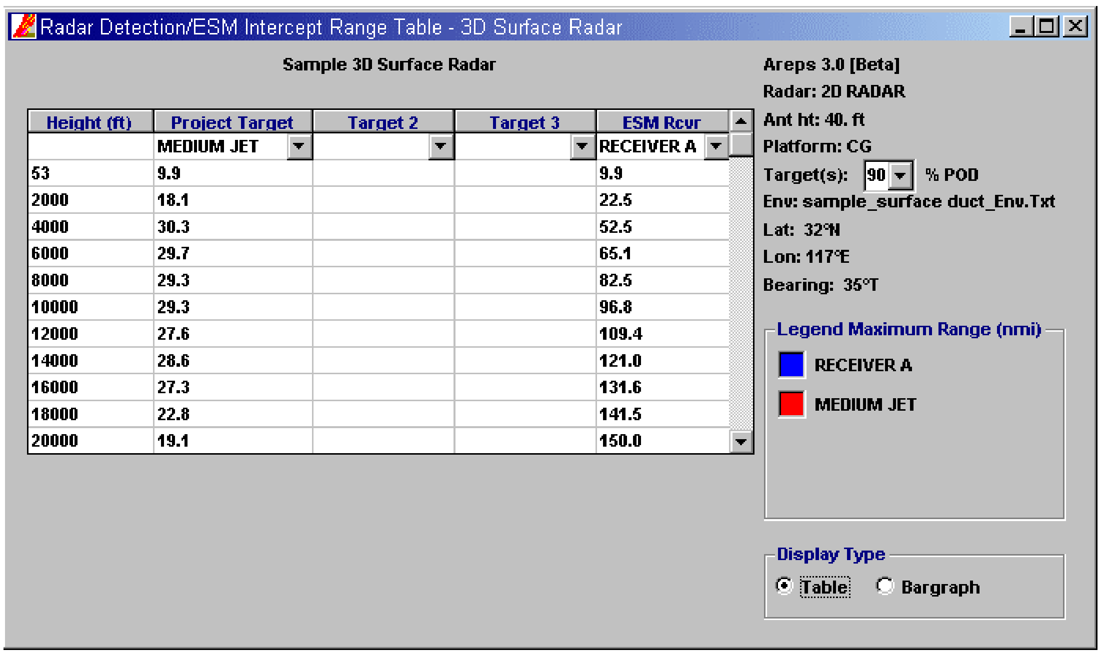


Figure 10-12: Maximum range tables decision aid – table format.

While the minimum display height of the project may be zero, the first height in the table may not be zero. This is because the APM does not calculate a propagation loss value at a height of zero for horizontally polarized antennas. The height shown will be the first height step as determined by APM. Should this height be higher than your interest, it will be necessary to re-execute the project with a lower maximum height (thereby decreasing the height step size in the APM).

By clicking the Bargraph option button, the contents of the table are displayed in a bargraph format, figure 10-13. From this display, you may not change targets or heights but you may still change the probability of detection or the range units. You may right-click on the bargraph or the labels to obtain additional information or options.

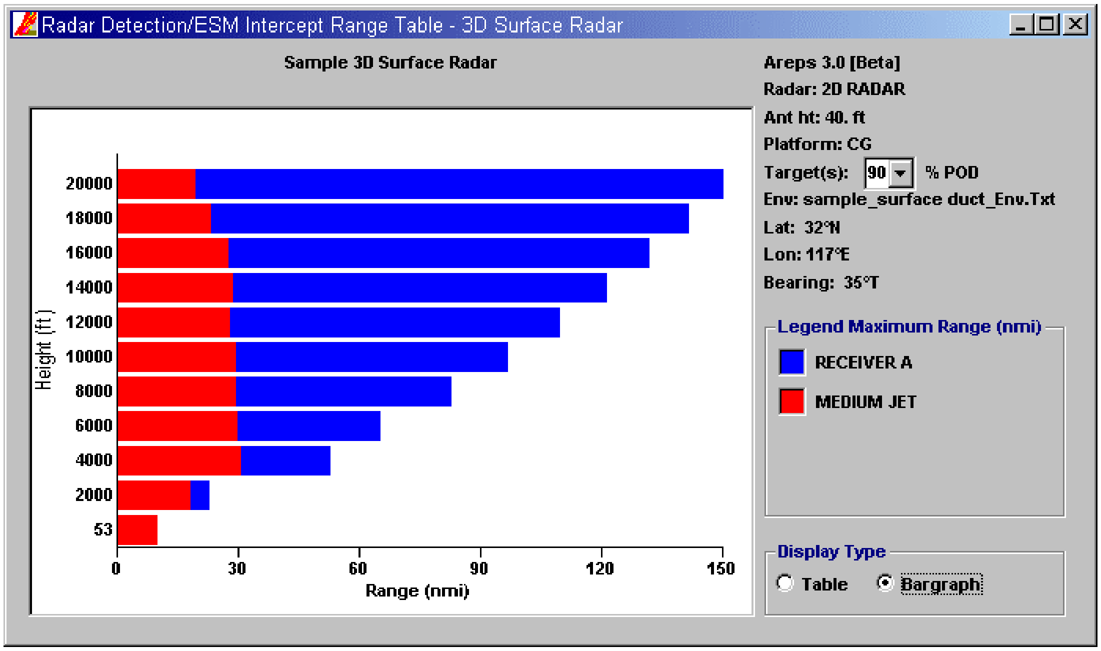


Figure 10-13: Maximum range tables decision aid – bargraph format.

Area Coverage Displays

By right clicking anywhere within the coverage display graphic, you many select the area coverage, figure 10-14. When the display first opens, it shows you the radar detection, ESM intercept, or communication range for all your project's bearings at the altitude clicked on from the height versus range coverage display. The display is superimposed upon either a DTED terrain map for your project’s area or a uniformly colored background if you have not used DTED data. As the mouse pointer is moved over the display, additional information is shown to the right of the graphic.

You may change the display altitude by entering a number in the display height text box and pressing the Enter key. The lowest altitude is the minimum altitude calculated by APM. You may not display a lower altitude.

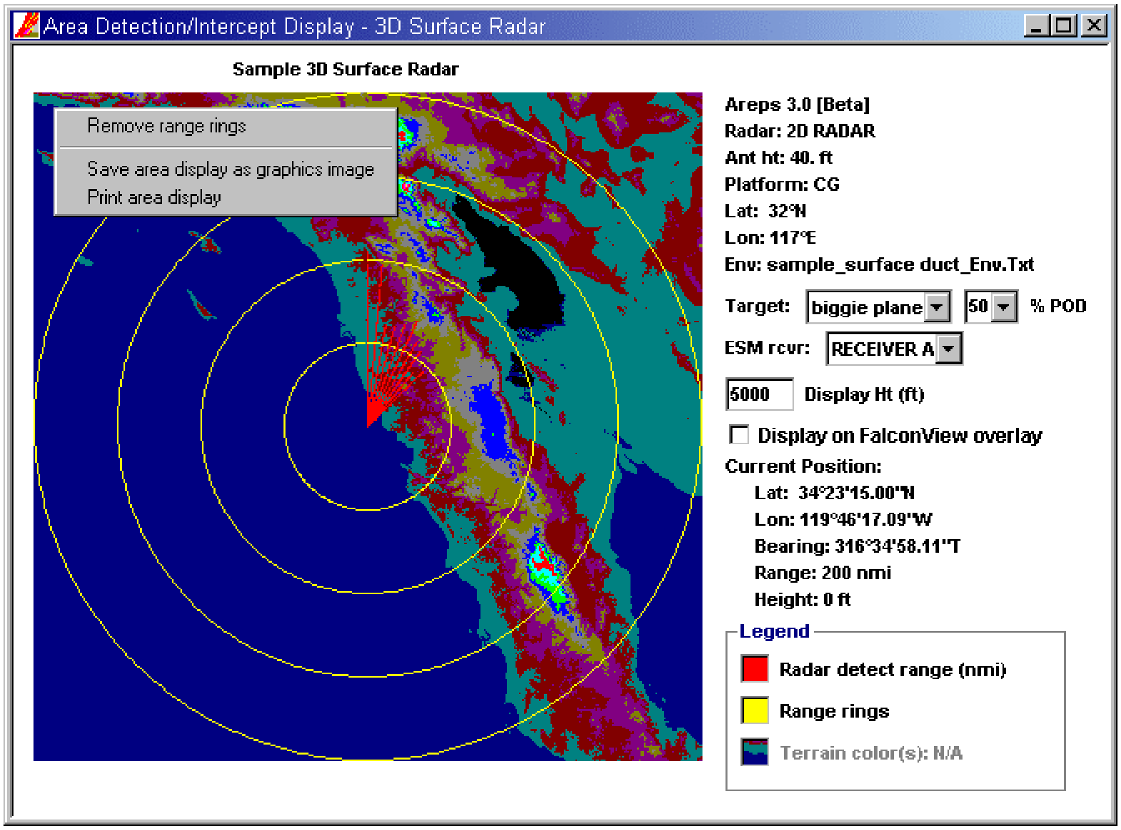


Figure 10-14: Area coverage display.

Depending upon your project, you may select a different target, radar probability of detection, ESM receiver, or communications receiver from the dropdown menus. Changing an item will cause an automatic redisplay.

To change units of height or range, right-click on the appropriate label and select the units from the popup menu. Again, changing units will cause an automatic redisplay.
To change display colors, right-click on the appropriate legend color box and select a new color from the popup menu. If you are using DTED data, this version of AREPS will not allow you to change individual terrain height colors.

To select other options, right-click on the area display graphic or other labels and select them from the popup menu. For example, if you right-click the Radar label, all the radar's parameters are shown in a general-purpose listing window.

If you have the N-PFPS FalconView software installed, you may also display these AREPS data upon the FalconView display window. To do this, click the Display on FalconView overlay checkbox.

FalconView overlay display

By selecting a FalconView overlay from the AREPS file menu or by clicking on the FalconView overlay quick action command button, the FalconView overlay window opens allowing you to specify EM system and environmental parameters for the propagation model calculations. The results of these calculations are then shown on the FalconView display itself. You may then change parameters and re-execute the project for additional overlays.

Figure 10-15 illustrates an evaluation for the coverage of two radars in the Southern California area under a surface-based ducting condition. Areas of coverage, surface-based duct skip zones, terrain masking, etc. are clearly visible.

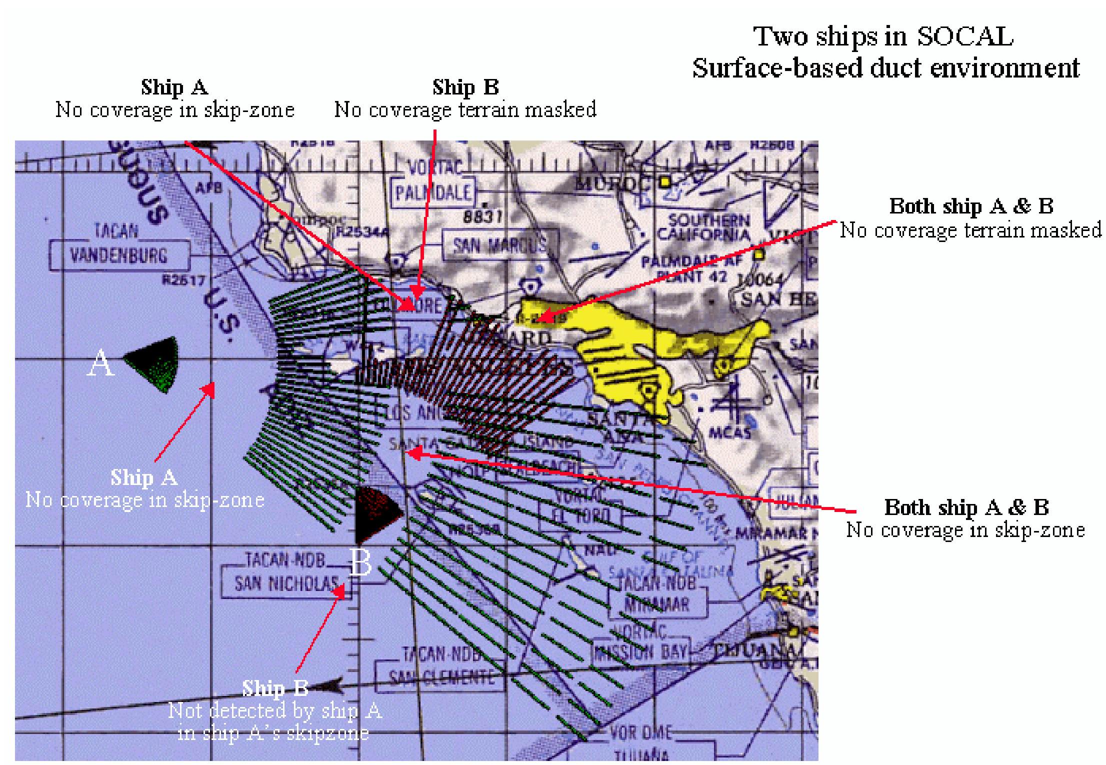


Figure 10-15: Area coverage display upon a FalconView map background.

TACTICAL APPLICATIONS

Strike and Electronic Counter Measures Considerations

One tactic employed by an attack aircraft in penetrating an enemy target's defenses is to fly as low as possible to remain "beneath" the radar coverage. This may be a valid tactic during non-ducting conditions. For surface-based ducting conditions, however, the enemy is given a greater detection range capability for targets flying within the duct than for targets at higher altitudes. Knowledge of the existence and height of a surface-based duct would enable the strike group or aircraft commander to select the optimum altitude for penetration. This would be just above the top of the duct.

In a manner similar to that described for the strike case, an ECM aircraft may adjust its position to maximize the effectiveness of its jammers by using the coverage display. By flying within a duct, the aircraft will be more easily detected but, at the same time, its jamming effectiveness will be greatly enhanced and its standoff range will be greatly extended.

While it may be possible to avoid detection by flying down an interference null, the changing height versus range profile would be more difficult to fly and, if the aircraft were off course or the null pattern changed somewhat, due to the target ship's roll for example, detection would occur. In addition, several radars operating at different frequencies would usually defend ship or land targets. The constructive interference pattern for one radar would most likely fill in the destructive interference pattern of the second radar, thereby increasing the likelihood that this maneuver will be unsuccessful.

The decision aid for standard atmospheric conditions, figure 11-1, shows that a strike aircraft flying just above the terrain should not be detected until it is within 18 nautical miles of the defending radar. Should the aircraft be making its ingress at an altitude of 6000 feet, the detection probabilities rapidly increase at ranges beginning at 72 nautical miles from the defending radar. For this standard atmosphere case and neglecting other tactical considerations such as surface-to-air missile threats, the optimum strike altitude is as close to the terrain as the aircraft can safely fly. An ECM jamming aircraft however would have an optimum altitude of 6000 feet, as this will provide the greatest standoff range coupled with the greatest jamming effectiveness.

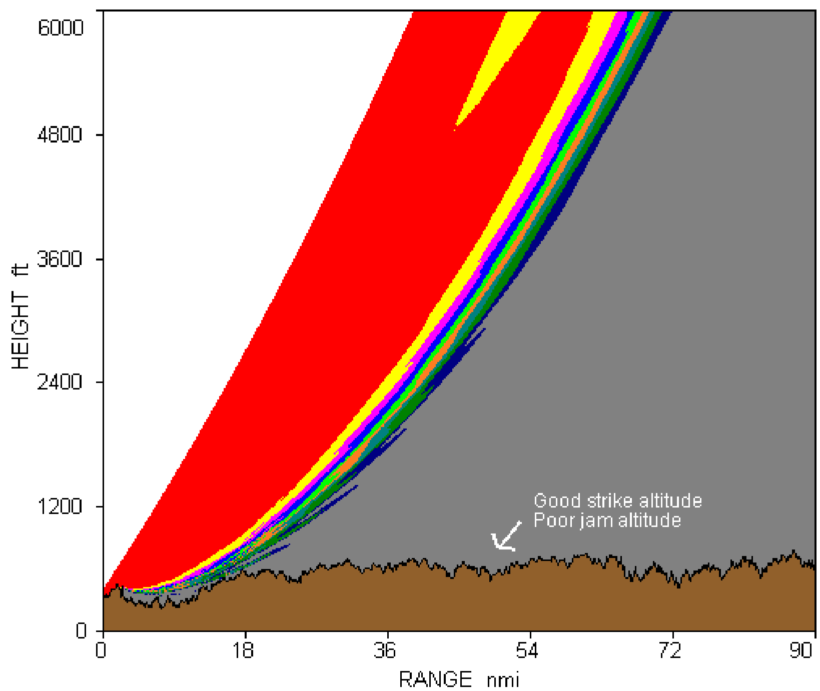


Figure 11-1: Coverage display for standard atmosphere.

Using the same principles under a surface-based ducting environment, illustrated in figure 11-2, if the strike aircraft is flying just above the terrain, the probabilities of detection greatly increase beginning at a range of 80 nautical miles from the defending radar.

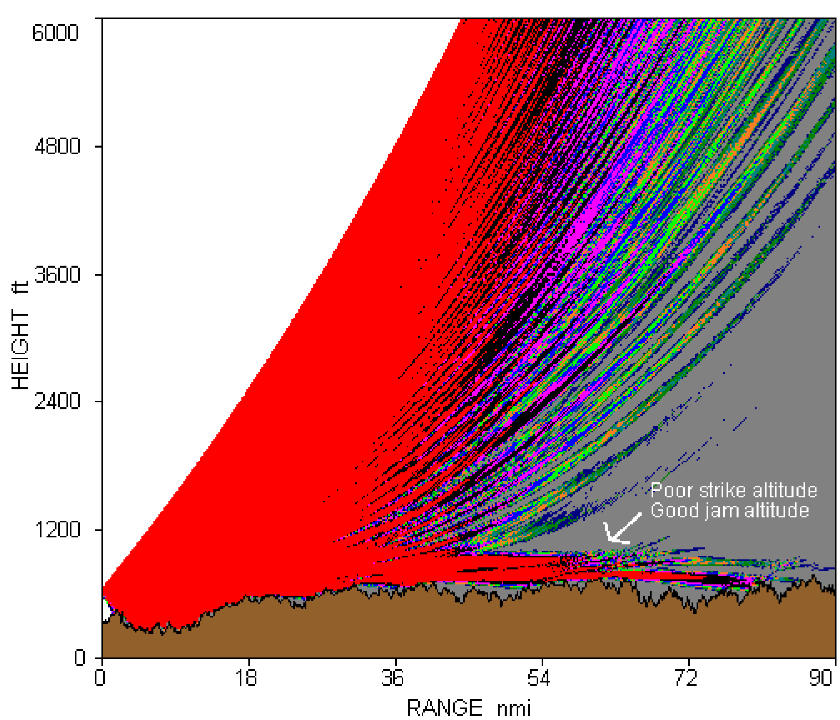


Figure 11-2: Coverage display for a surface-based duct atmosphere.

Note also, should the strike aircraft be making its ingress at an altitude of 6000 feet, the detection probabilities rapidly increase at ranges over 90 nautical miles from the defending radar. Thus, for a surface-based ducting environment, the optimum strike altitude is neither low nor high but just above the duct's top, an altitude of approximately 1000 feet. While a jamming aircraft will have success at high altitudes, its greatest jamming effectiveness is at altitudes closest to the terrain.

Early Warning Aircraft Stationing Considerations

By using the coverage decision aid, the optimum altitude for early warning aircraft can be determined, which will minimize the effects of radar "holes" or "shadow zones" created by elevated ducts or terrain features. It should be remembered that although the duct acts like a waveguide for the energy, this waveguide does not have rigid and impenetrable boundaries, except for the earth's surface in the case of surface-based ducts. Therefore, energy is continually "leaking" from the duct into the hole. In addition, surface-reflected energy may propagate into this hole. While the energy level within a radar hole may be insufficient for radar detection, it may be sufficient for ESM intercept.

The coverage decision aid, figure 11-3, illustrates the principles discussed above. For this case, there is an elevated duct between 19,000 and 20,000 feet. The aircraft is flying within the duct. Extended ranges for high probability of detection can be seen within the duct.

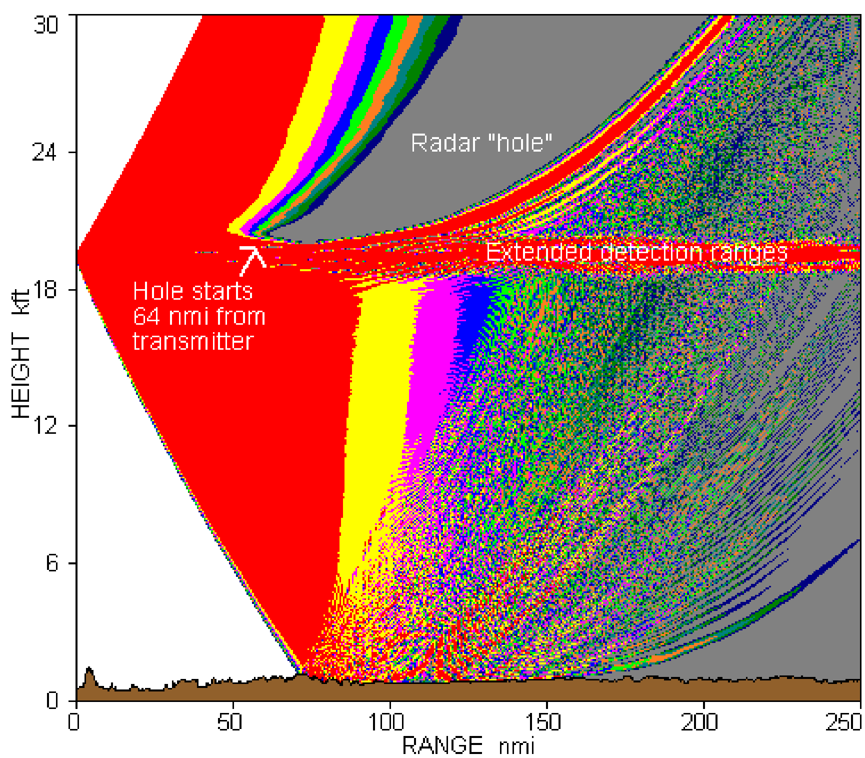


Figure 11-3: Early warning aircraft within an elevated duct.

The radar hole is evident above the duct. In addition, you can see energy leaking upward from the duct, defining a down-range boundary for the hole, and you can see surface-reflected energy reaching the atmosphere above the duct and beyond the down-range hole boundary. Note that for this case, the hole starts at 64 nautical miles from the transmitter.

Tactically, flying within an elevated duct is not desirable, as the aircraft will experience the greatest area of reduced coverage. While it's true the extended ranges within the duct do exist, the likelihood of the target also being within the duct cannot be counted on. In addition, an ESM intercept aircraft could tactically exploit these extended ranges by stationing himself at ranges beyond radar detection but still within ESM intercept ranges.

Now consider the AEW aircraft ascending to an altitude of 25,000 feet, illustrated in figure 11-4. While the radar hole is still present, it starts 95 nautical miles from the transmitter. The higher the transmitter is above the duct, the farther in range the hole will begin. Also notice that extended ranges within the duct are not present. Here again, there is a tactical tradeoff, i.e., no extended ranges but better overall coverage.

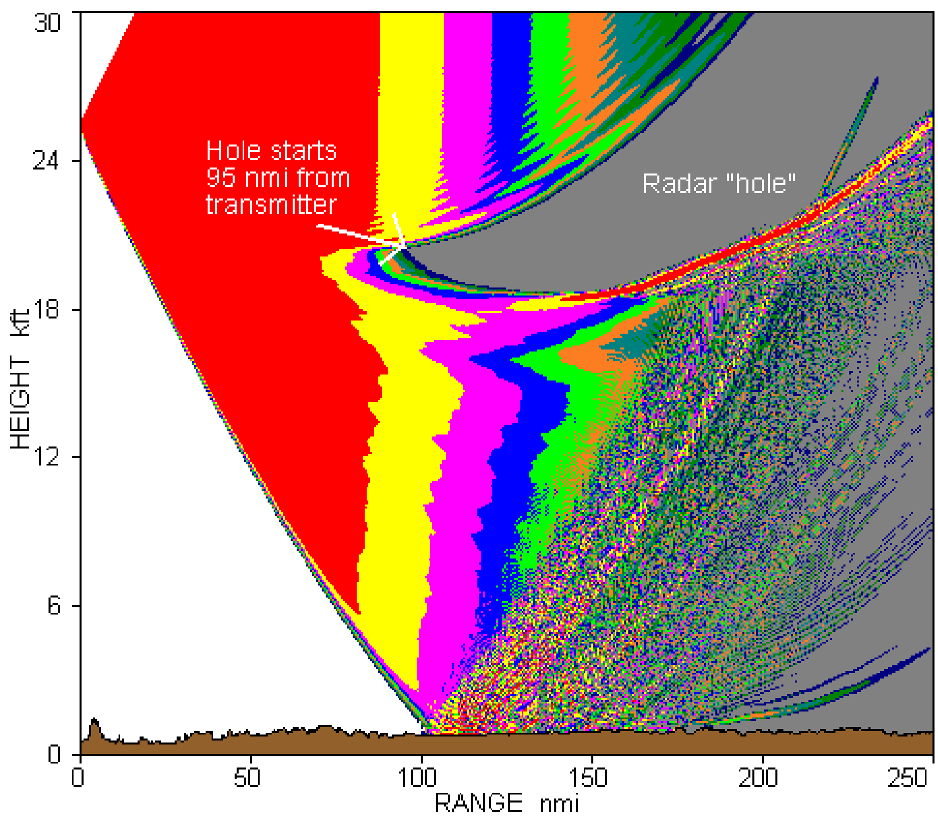


Figure 11-4: Early warning aircraft above an elevated duct.

In figure 11-5, the early warning aircraft positions itself at an altitude of 15,000 feet. Notice that since the transmitter is now below the elevated duct, there are no anomalous propagation effects from the duct, i.e., no extended ranges and no radar hole.

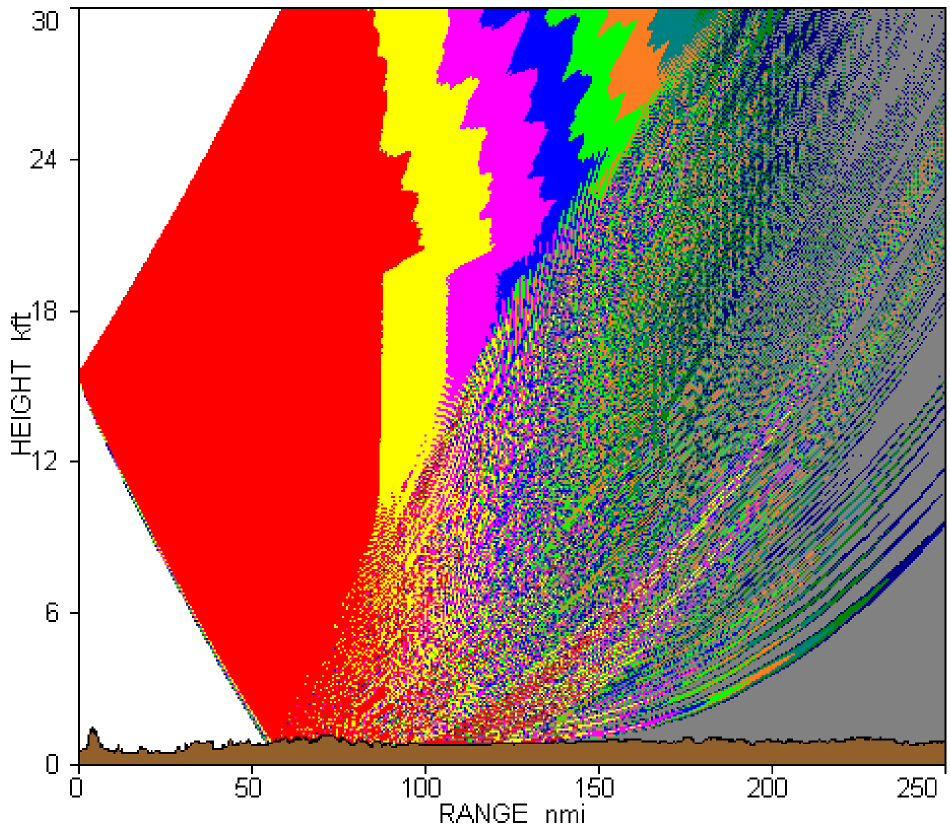


Figure 11-5: Early warning aircraft below an elevated duct.

Thus, as a rule-of-thumb, the positioning of an early warning aircraft in relation to the elevated duct is to fly as high above the duct as possible or fly anywhere below the duct, consistent with other mission objectives including radar/communication horizon, fuel usage, height assignments by traffic control, etc.

Electronic Surveillance Measures (ESM)

Oftentimes it is advantageous to know not only the detection ranges of threat targets, but also your own vulnerability to ESM intercept by an enemy. For example, you are concerned about detecting a low-flying anti-radiation missile (ARM) but, at the same time, you are concerned about providing the missile's seeker with extended detection range. Likewise, when creating an emissions control plan, for example, a task force, it is of great value to know which systems are most vulnerable to intercept. A tradeoff study of emitters can be made to determine placement and use of emitters to defend your position yet remain undetected for as long as possible. These considerations can be made with the radar/ESM vulnerability display.

The tactical situation could also be applied in a reverse sense. For example, you may be airborne, trying to approach a heavily defended area, giving as little advance notice as possible. You do this by not radiating an EM system except for your downward looking terrain following radar. Using the radar/ESM vulnerability display, you will be able to assess the effects of diffraction over terrain features. While the main beam of the radar is pointed toward the ground, energy is still being radiated outward through the sidelobes. The sidelobe energy could be diffracted forward over steep terrain to an ESM receiver at the defended area, thereby giving unsuspected advanced notice of your arrival.

Consider a mission to approach a hostile coastline and provide AAW surveillance for the protection of an amphibious landing force, illustrated in figure 11-6.

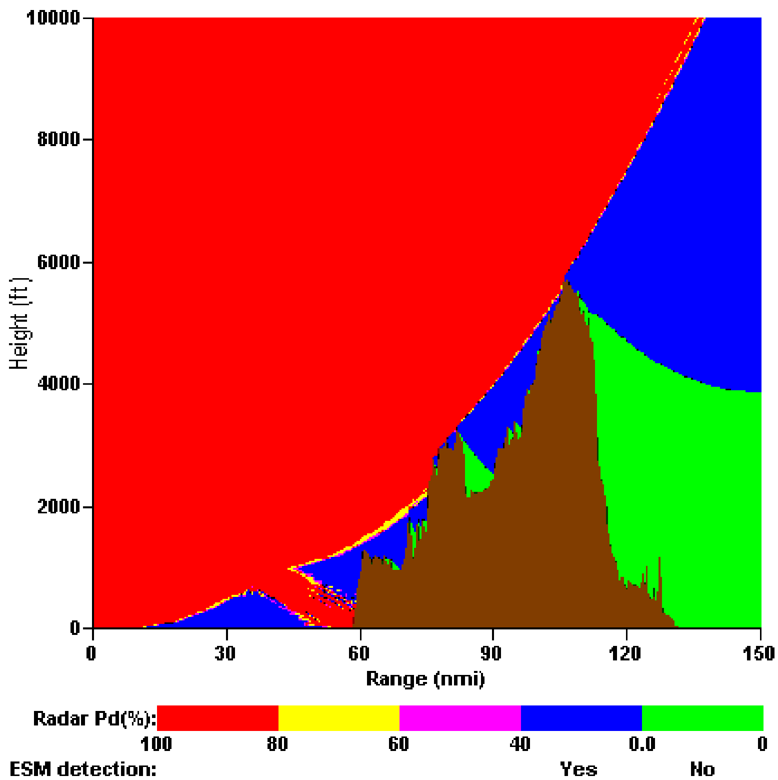


Figure 11-6: Radar and ESM intercept decision aid.

For this mission, it is highly desirable to remain undetected for as long as possible. You anticipate the coastal mountain ranges will provide you cover from ESM intercept. Using the combination radar detection and ESM vulnerability decision aid, you can visualize your detection ranges for the anticipated threat aircraft and also see the vulnerability of your air surveillance radar to a hostile ESM receiver. In this example, the environment is a surface-based duct at your ship's location that rises to become an elevated duct over the coastal terrain. This ducting condition provides fairly reasonable detection for targets at ranges of 100 nautical miles. As you would expect, your radar is vulnerable to intercept at even greater ranges. You can see, however, an ESM receiver that is located 120 nautical miles away and within a valley beyond 2 mountain ranges, is still capable of intercepting your radar's energy. The coastal mountains do not provide the intercept protection you were expecting. For this case, the mission commander may choose to use an airborne platform for AAW surveillance instead of a ship platform.

UHF/VHF Communications

It is commonly thought that UHF/VHF communications is a line-of-sight event. This is true under standard atmospheric conditions. Consider a tactical application such as a ship trying to communicate with ground troops over a water and terrain path. The communications decision aid shown in figure 11-7, for a standard atmosphere indicates a loss of surface communications at a range of approximately 8 nautical miles.

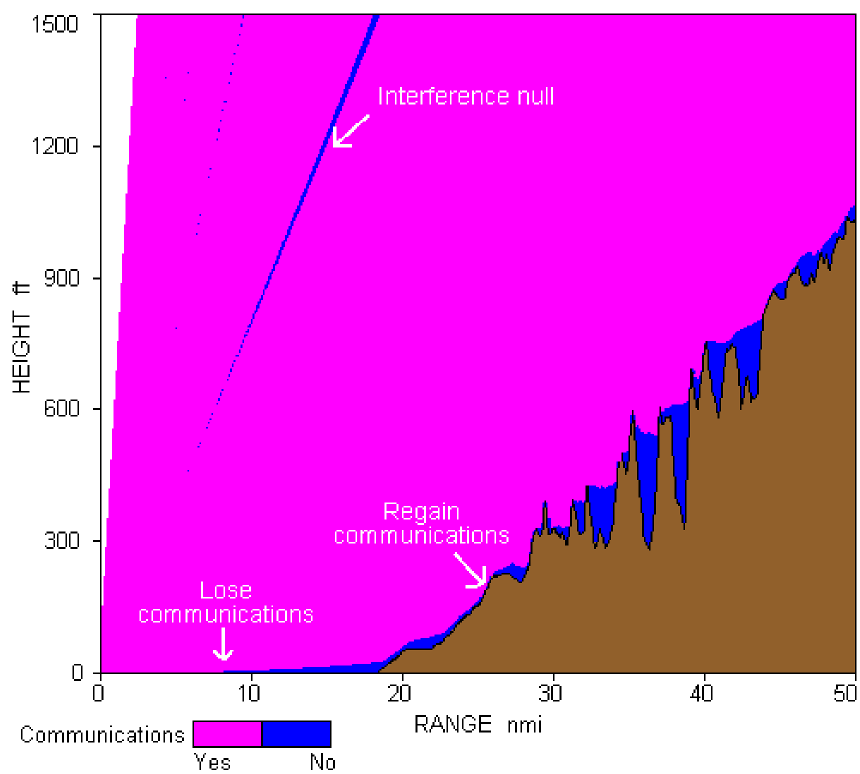


Figure 11-7: UHF communications decision aid.

Communications is not regained until 25 nautical miles from the ship with the troops at an altitude of 250 feet. By examining the areas of no communications, the ashore forces can determine a good location to establish a command center with adequate communications to the afloat platform or to aid in troop positioning.

Tactics for ASW helicopter operations may also benefit from the knowledge of ducting or non-ducting conditions. For example, under standard atmospheric conditions as illustrated in figure 11-8, the helicopter (at an altitude of approximately 50 feet) can maintain both ASW surveillance with its dipping sonar and communicate with the ship at a range of approximately 33 nautical miles.

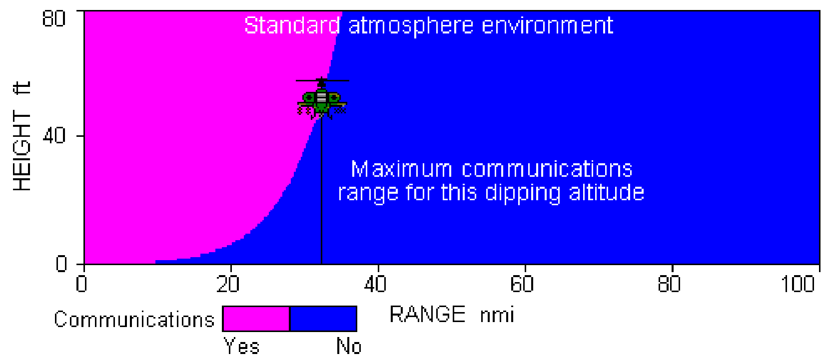


Figure 11-8: UHF communications under standard atmosphere conditions.

Under surface-based ducting conditions, figure 11-9, the helicopter at the same altitude could extend the communication ranges well beyond 60 nautical miles. In addition, the decision aid shows surface-based ducting skip zones that could preclude communications at certain ranges.

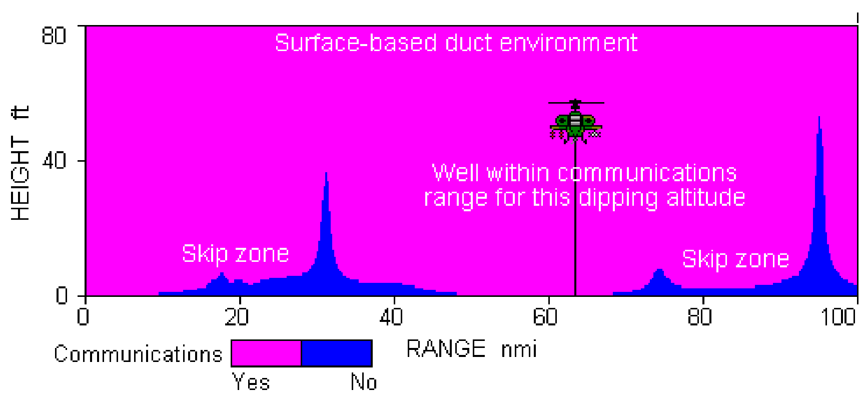


Figure 11-9: UHF communications under surface-based ducting conditions.

HF Communications

To meet an accelerated delivery schedule for HF (2 to 99 MHz) surface wave assessment, a limited capability requiring certain assumptions has been implementation in this version of AREPS. Future versions of AREPS will increase the capabilities for HF assessment and overcome the assumptions.

Once such limitation is that no signal-to-noise or other system threshold calculations are made. One reason is that the noise at HF is a function of the receiver's location, which AREPS does not currently include. Thus, the only decision aid available is the vertical cover display as shown in figure 11-10 below and the range/height display of propagation loss or propagation factor. **You must have some foreknowledge of signal levels you require for communications**.

The propagation effects of the surface wave below 10 MHz produce results that appear different (or strange) than those at higher frequencies as illustrated in figure 11-10. This is particularly true for over water paths where there are strong interference interactions within the wave. While we feel the model has been implemented correctly and the results are physically real rather than created by some numerical instability in the model, there are still some questions. If your frequency is below 10 MHz, you will receive this warning notice prior to AREPS execution.

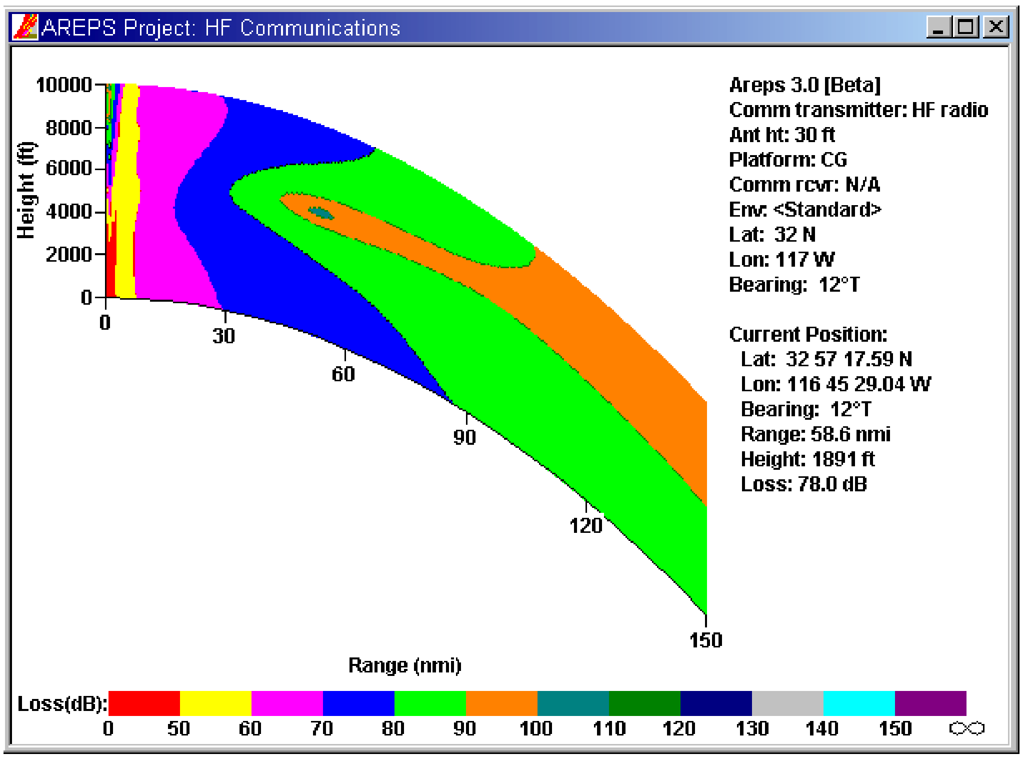


Figure 11-10: HF communications decision aid.

Use for Hardware Maintenance

An operator will experience days when detection of radar targets or communication with other units over the horizon is possible and days when extended ranges are not possible. In addition, the radar operator will experience false targets or radar "ghosts" under ducting conditions. Without the knowledge of anomalous propagation conditions, it may be thought that decreased ranges are indicative of hardware problems. Without knowledge of the interference patterns, signal fading in UHF communications may also be thought of as indications of hardware problems. A decision aid for the given day will explain such anomalies and, therefore, preclude unnecessary maintenance calls.

Consider the following example. A naval task force is traveling in formation with specified spacing between units. The Officer-of-the-Deck finds he is not able to communicate with the closest ship, yet can communicate with another ship farther away. The first thought may be that the radio receivers of the closest ship are not working correctly. Examining a communication coverage display as illustrated in figure 11-11 reveals, however, surface ducting conditions with its inherent "skip zones." The spacing between the two ships is such that the closest ship is within a skip zone while the farther ship is not. With this knowledge, the ship's spacing may be altered to avoid the skip-zones.

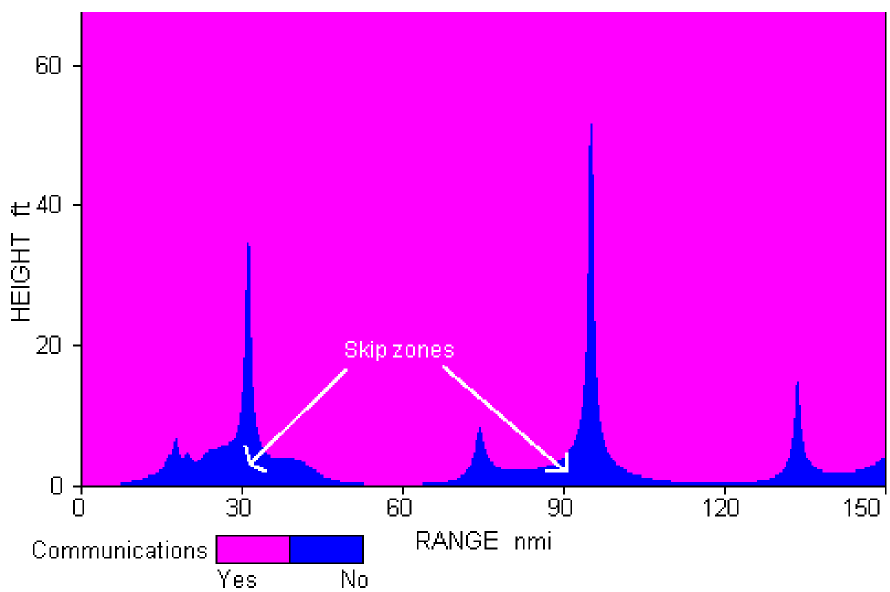


Figure 11-11: Surface-based ducting skip zone conditions.